Instruction Manual

MODEL 825A

DIFFERENTIAL VOLTMETER

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

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P. O. Box 7428 Seattle 33, Washington

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MODEL 825A
DIFFERENTIAL VOLTMETER

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TABLE OF CONTENTS

Section	Title	Page
I	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. Introduction	1-1
	1-2. Damage in Shipment	1-1
	1-3. Specifications	1-1
II	OPERATING INSTRUCTIONS	2-1
	2-1. Controls, Terminals and Indicators	2-1
	2-2. Zeroing Instructions	2-2
	2-3. Preliminary Operation	2-3
	2-4. Operation as a DC Differential Voltmeter	2-3
	2-5. Operation as A Conventional VTVM	2-3
	2-6. Measurement of Voltage Excursions About A Nominal Value	2-4
	2-7. Recording Voltage Excursions	2-4
	2-8. Measurement of High Resistances	2-5
	2-9. Notes on Measuring Voltages	2-5
III	THEORY OF OPERATION	3-1
	3-1. General	3-1
	3-2. DC Vacuum Tube Voltmeter	3-2
	3-3. 0 to 500 Volt Reference	3-3
	3-4. Polarity Switch	3-4
IV	MAINTENANCE	4-1
	4-1. General	4-1
	4-2. Preventative Maintenance	4-1
	4-3. Troubleshooting	4-2
	4-4. Calibration	4-5
V	LIST OF REPLACEABLE PARTS	5-1
	5-1. General	5-1
	5-2. How to Obtain Parts	5-1
VI	ACCESSORIES	6-1
	6-1. Precision Voltage Dividers	6-1
	6-3. Isolation Amplifier	6-2
	WARRANTY	
	CIRCUIT DIAGRAM	

LIST OF ILLUSTRATIONS

Figure	Title	Page
Frontispiece	825A Precision DC Differential Voltmeter	Page
2-1	Controls, Terminals, and Indicators (sheet 1 of 2)	2-1
2-1	Controls, Terminals, and Indicators (sheet 2 of 2)	2-2
2-2	Recommended Null Settings	2-3
2-3	VTVM Ranges	2-4
3-1	825A Differential Voltmeter Block Diagram	3-1
3-2	Function of Polarity Switch	3-4
4-1	Chopper Cleaning	4-1
4-2	Troubleshooting (sheet 1 of 2)	4-2
4-2	Troubleshooting (sheet 2 of 2)	4-3
4-3	Tube Voltage Chart	4-4
4-4	Transistor Voltage Chart	4-5
4-5	Calibration Equipment	4-6
4-6	Adjustment Locations (sheet 1 of 2)	4-6
4-6	Adjustment Locations (sheet 2 of 2)	4-7
5-1	Final Assembly	5-2
5-2	Front Panel Assembly (sheet 1 of 2)	5-4
5-2	Front Panel Assembly (sheet 2 of 2)	5-5
5-3	Reference Supply Printed Circuit Board Assembly	5-7
5-4	Null Detector Assembly (sheet 1 of 2)	5-10
5-4	Null Detector Assembly (sheet 2 of 2)	5-13
5-5	Range Resistor Board Assembly	5-15
5-6	Kelvin-Varley Resistor Board Assembly	5-16

825A & 825A/AG

825AR & 825AR/AG

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 825A series Differential DC Voltmeters. The 825A voltmeters are available with either a standard cell or a Zener diode as the reference element. Models containing the Zener diode option are denoted by a /AG in the model number. Both the standard cell option and the Zener diode option are available in a cabinet model or a model designed to fit a standard 19 inch rack. Rack models are denoted by an R immediately following the 825A part of the model number.

b. The high accuracy, portability, and compactness of the 825A make this instrument ideal for the precise measurement of almost any DC voltage. Ease of operation, inherent protection from accidental overload, and high reliability contribute to the outstanding performance that assures suitability for both production line testing and precision laboratory measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source when balance is attained. Thus the determination of the unknown potential is independent of its source resistance. The 825A is basically used for measurements of DC voltages from 0 to 500 volts. However, high accuracy measurements to 30,000 volts DC are possible with precision voltage dividers especially designed for use with the Fluke Model 800 Series Differential Voltmeters. As additional features, this instrument contains a polarity switch for equal convenience in measuring positive or negative voltages and an adjustable recorder output which makes the 825A particularly useful for monitoring the stability of almost any DC voltage. Furthermore, the 825A meter has tautband suspension which eliminates problems due to meter stickiness.

c. When used as a differential voltmeter, the 825A operates on the potentiometric principal. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by setting the reference supply with a standard cell for the 825A and 825AR and with a Zener diode for the 825A/AG and 825AR/AG. The known adjustable reference voltage is provided by a 500 volt DC power supply and five Kelvin-Varley decade resistor strings that are set accurately by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. In the highest null sensitivity range, potential differences between the unknown and the reference voltage of only 0.001 volts will cause full scale meter deflection.

d. The instrument is normally supplied ready for use on 115 volts. Upon request, instruments are supplied for 230 volts operation. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the back of cabinet models or on the cover in rack models.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. SPECIFICATIONS

AS A PRECISION POTENTIOMETER

ACCURACY: ±0.02 % of input voltage from 0.1 volt to 500 volts. ±(0.02 % + 25 uv) below 0.1 volt.

RANGE

Input Voltage Range	Recommended Null Range*	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0-0.5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

*Any null range may be used with any input voltage range; recommended ranges are those most useful.

RESOLUTION: Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Range Setting	Null Setting	Resolution
any	10	50 mv
any	1	5 mv
any	0.1	0.5 mv
any	0.01	0.05 mv
any	0.001	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% on all ranges

RANGE:

Voltage Ranges	Input Resistance
500-0-500	50 Meg
50-0-50	50 Meg
5-0-5	50 Meg
0.5-0-0.5	50 Meg
10-0-10*	10 Meg
1-0-1*	10 Meg
0.1-0-0.1*	10 Meg
0.01-0-0.01*	10 Meg
0.001-0-0.001*	1 Meg

*These ranges are obtained by using Null ranges with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS

REGULATION AND STABILITY OF 500 VOLT SUPPLY:

±0.0025% for a ±10% line change.
±0.005% per hour after 30 min. warmup.

STABILITY OF METER ZERO:

±0.25% of full scale for a ±10% line change.

OPERATING TEMPERATURE RANGE:

Model 825A and 825AR (Standard cell reference element). Within DC accuracy specifications from 55°F to 95°F, derated at 0.001%/°F outside these limits to 35°F and 110°F.

Model 825A/AG and 825AR/AG (Zener diode reference element). Within DC accuracy specifications from 55°F to 95°F, derated at 0.001%/°F outside these limits to 0°F and 125°F.

RELATIVE HUMIDITY:

Within specifications from 0 to 80% relative humidity.

SHOCK AND VIBRATION:

Meets requirements of MIL-T-945A.

INPUT POWER:

115/230 VAC ±10%, 50 - 440 cps, approximately 60 watts.

DIMENSIONS:

Cabinet Model - 13" high, 9-3/4" wide, 14" deep.
Rack Model - 7" high, 19" wide, 14" deep.

WEIGHT:

Cabinet Model - 22 lbs.
Rack Model - 19 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

The location, circuit symbol, and a functional description of external controls, terminals, and indicators on the 825A Precision Differential DC Voltmeter may be found in figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Input terminals	Front panel	J1, J3	Provided for connecting DC voltage to be measured.
Chassis ground terminal	Front panel	J2	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. The upper input post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting lower input binding post (middle post) to the chassis post.
Power toggle switch	Front panel	S1	Applies AC line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt DC reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell, or Zener diode for the /AG models, and any difference is indicated on the meter.
CALIBRATE control	Front panel	R2	Varies the output of the 500 volt DC reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is accurately set by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null voltage ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. These ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Provide an in- line readout of the amount of internal reference voltage necessary to null the unknown voltage.
Decimal lights	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
Polarity switch	Front panel	S5	Changes polarity of 825A to match polarity of unknown voltage. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	Rear panel	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	Rear panel	R1	Varies the output level of the output binding post from 0 to approximately 20 millivolts full scale deflection.
Meter	Front panel	M1	Indicates approximate voltage when 825A is in VTVM mode and difference between unknown and internal reference voltage when 825A is in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM. At all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	Meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the meter terminals have been shorted.
Fuse	Rear panel of 825A, front panel of 825AR	F1	Fuse holder protrudes from instrument to provide easy access to the fuse.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 2 of 2)

2-2. ZEROING INSTRUCTIONS

From time to time, it may be necessary to adjust the internal meter zero control. This will normally be done at somewhat more frequent intervals than regular calibration for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628. For later instruments, it should only be necessary to adjust the internal meter zero control during regular calibration. Proceed as follows:

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the meter terminals prior to zeroing.

b. Set power switch to ON and allow a 20 minute warmup period.

c. Set RANGE switch to 5 or 0.5 volts, voltage readout dials to zero, and NULL switch to 0.001 volt.

d. Adjust R212 (R232 for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628), VTVM ZERO ADJ, for zero meter deflection. This control may be reached through the ventilation holes in the cabinet model (see figure 4-6). In the rack model, an identified access hole is provided on the rear panel. If the meter cannot be zeroed for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628, clean chopper as outlined in paragraph 4-2d.

2-3. PRELIMINARY OPERATION

The following procedure prepares the voltmeter for operation.

a. Connect power plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC.

NOTE

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short lead to suitable ground.

b. Set controls on 825A voltmeter as follows:

RANGE	500 volts
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt DC reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

2-4. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, connect unknown voltage to input binding posts. If one side is grounded, always connect it to the lower input post (middle post).

b. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

c. If meter reads to the left, turn polarity switch to the negative position. The meter needle will deflect to the right. This is because polarity of unknown voltage is negative.

d. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step b. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set NULL switch to successively more sensitive null ranges, as indicated in figure 2-2, and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01 (then 0.001 for voltages from 0.5 to 1 volt)
0-0.5	0.01 then 0.001

*Any null range may be used with any input voltage range; recommended settings are those most useful.

Figure 2-2. RECOMMENDED NULL SETTINGS

f. Read unknown voltage directly from the five voltage readout dials.

2-5. OPERATION AS A CONVENTIONAL VTVM

If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation procedures as stated in paragraph 2-3.

b. Consult figure 2-3, and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.

c. Set RANGE switch, NULL switch, and voltage dials as indicated for the range selected.

d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that unknown DC voltage is of positive polarity.

e. Read voltage from upper or lower scale as listed in figure 2-3.

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS	METER SCALE
DC				
500-0-500	500	VTVM	No effect	Upper
50-0-50	50	VTVM	No effect	Upper
5-0-5	5	VTVM	No effect	Upper
0.5-0-0.5	0.5	VTVM	No effect	Upper
10-0-10	No effect	10	All zero	Lower
1-0-1	No effect	1	All zero	Lower
0.1-0-0.1	No effect	0.1	All zero	Lower
0.01-0-0.01	No effect	0.01	All zero	Lower
0.001-0-0.001	No effect	0.001	All zero	Lower

Figure 2-3. VTVM RANGES

2-6. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3.

b. Connect voltage to be observed to input binding posts. If meter reads to the left, the voltage being measured is negative; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.

c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.

d. Set the five voltage readout dials to nominal voltage.

e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.

f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting. Meter deflection to the right indicates that the voltage under observation has increased above the nominal value while deflection to the left indicates it has decreased.

2-7. RECORDING VOLTAGE EXCURSIONS

a. GENERAL. Recorder output binding posts and an output level control are provided on the 825A for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage readout dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the voltmeter will be impaired. Therefore, the FLUKE Model A88 Isolation Amplifier is recommended for this application. The A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder.

b. USE OF 825A WITH A88 AND A RECORDER. To use the A88 Isolation Amplifier and a recorder with the 825A, proceed as follows:

(1) Set A88 POWER switch to ON.

(2) When batteries are being used as a power source for A88, measure voltage at BATT TEST jacks. If voltage is between 11.7 and 14 volts DC, the batteries are satisfactory for use. However, if battery voltage is below 12.8 volts, batteries are approaching end of their useful life and should be replaced.

(3) Connect output terminals of differential voltmeter to INPUT terminals of isolation amplifier with teflon leads.

(4) Connect OUTPUT terminals of isolation amplifier to recorder input terminals.

(5) Perform preliminary operation as stated in paragraph 2-3.

(6) Short input terminals of 825A and set switches as follows:

polarity	+ (positive)
RANGE	50
NULL	10
voltage readout dials	10.000

The 825A meter will indicate full scale. This provides up to a maximum of at least 18 millivolts at the output terminals depending on setting of the output level control.

(7) Turn on recorder and set recorder gain so that a recorder input of either ±2 volts or near maximum if maximum is below ±2 volts will cause recorder deflection desired for full scale deflection of differential voltmeter.

(8) Adjust output level control on differential voltmeter until recorder deflection obtained is that desired to correspond to full scale deflection of the differential voltmeter.

(9) Remove short from input terminals of the 825A. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-6.

c. USE OF 825A WITH A RECORDER. To use a

recorder with the 825A, proceed as follows:

(1) Connect 825A output terminals to input terminals of recorder with teflon leads.

CAUTION

Do not ground either of the 825A recorder output terminals or either of the recorder input terminals. If any of these terminals are grounded, current will be drawn from the 825A Kelvin-Varley voltage divider and the 825A will no longer be accurate.

(2) After connecting the recorder, perform preliminary operation as stated in paragraph 2-3.

(3) Check for excessive leakage as follows:

(a) Connect a DC voltage to the input of the 825A and differentially measure its potential in a recommended null range.

(b) Alternately connect and disconnect the recorder leads from the output terminals of the 825A while noting the meter needle deflection. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 825A voltmeter.

(c) Disconnect the voltage.

(4) After the leakage test has been successfully completed, short input terminals of 825A.

(5) Set switched on 825A voltmeter as follows:

polarity	+ (positive)
RANGE	50
NULL	10
voltage readout dials	10.000

The 825A meter will indicate full scale deflection. This provides up to at least 18 millivolts at the output terminals depending on the setting of the output level control.

(6) Turn output level control until recorder deflection obtained is that desired to correspond to full scale deflection of 825A.

(7) Remove short from input terminals of 825A. The 825A and recorder are now ready for combined use. Proceed as instructed under paragraph 2-6.

2-8. MEASUREMENT OF HIGH RESISTANCES

One of the important features of the 825A voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from 1 megohm to 250,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_X = 10\left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_X = unknown resistance in megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

a. FROM 1 MEGOHM TO 490 MEGOHMS. For rapid measurement of resistances from 1 megohm to 490 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

b. FROM 490 MEGOHMS TO 5000 MEGOHMS. For rapid measurements, of resistances from 490 to 5000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

c. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurements, of resistances from 5,000 to 50,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

d. FROM 50,000 MEGOHMS to 250,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 250,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for a convenient meter deflection.

(5) The resistance in megohms may be calculated by substituting the meter reading in volts (E_m, 0 to 0.1 volt on bottom scale) and the voltage readout dial setting (E) into the following equation:

$$R_X = 10\,\frac{E}{E_m} \text{ megohms}$$

2-9. NOTES ON MEASURING VOLTAGES

a. ADJUSTMENT OF 500 VOLT SUPPLY. The 500 volt DC reference supply may be adjusted (paragraph 2-3, step c) at any time deemed necessary without heed to the position of the switches and without removing any

input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to insure that 500 volt reference supply does not shift during the final warmup phase.

b. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 825A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect 825A input binding posts to chassis ground post.

c. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input binding post to the chassis ground post to reduce the effect of circulating AC currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged through leakage resistance over a period of time, if there is no external connection to the input terminals and the controls are set as follows: range to 500, null to any null range, polarity to +, and voltage readout dials to several hundred volts. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input post to the ground post will discharge C1 and thus prevent an inaccurate indication.

d. RECOMMENDED NULL RANGES. Certain null ranges are recommended for use with each setting of the RANGE switch for the following reasons. With the RANGE switch at 500 volts, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1, 0.01, or 0.001 volt NULL range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Finally, the regulation of the reference supply is approximately 0.0025%, or ±0.0125 volt for a 10% change in line voltage. Although this is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the 825A to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts, a line change of 10% may cause the 500 volt reference supply to change as much as 12.5 mv. Although this is small, the 825A will indicate full scale for a change as little as 100 mv, 10 mv, or 1 mv if attempting to use the 0.1, 0.01, or 0.001 null ranges.

e. EFFECT OF AC COMPONENTS. An AC component of several times the unknown DC may be present on the unknown and the 825A will always indicate well within the specifications for frequencies over a few hundred cycles. An AC component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any AC present on the DC being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the AC component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle AC voltage that is 10% of the input voltage will cause an error of approximately 0.001% which is well within the specifications. Also, since the input attenuation is less for the more sensitive null settings, the accuracy may be affected only on the more sensitive null settings. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 94 cycles), the meter needle will oscillate at the difference frequency. If AC components that affect the accuracy are ever encountered, additional filtering will be required. For an AC of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an AC variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

f. MEASUREMENT OF NEGATIVE VOLTAGES. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case, either at the 825A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch, the upper input post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

a. Figure 3-1 shows the block diagram for the 825A Differential Voltmeter. As seen in this figure, the circuit is mainly composed of a sophisticated DC vacuum tube voltmeter (vtvm) and an extremely accurate 0 to 500 volt reference. The vtvm uses a null detector, an input attenuator, and a meter to obtain high sensitivity. The 0 to 500 volt reference uses a range divider and a Kelvin-Varley attenuator to make the output of a well regulated 500 volt DC power supply adjustable. Refer to the functional schematic following Section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the voltmeter may be summarized as follows. To measure the approximate value of a DC voltage, the unknown voltage is connected directly across the DC vtvm input attenuator. This attenuator is set in such a way that the maximum voltage for each range is reduced to a signal of 1 millivolt. The 1 mv signal is applied to the null detector and causes 100 microamperes to flow through the meter for full scale deflection. To accurately measure a DC voltage, the unknown voltage is connected across the series combination of the vtvm and the 0 to 500 reference. The reference voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the vtvm.

c. In order to provide for a more complete understanding of the 825A voltmeter, the following paragraphs describe each section of the circuit in detail.

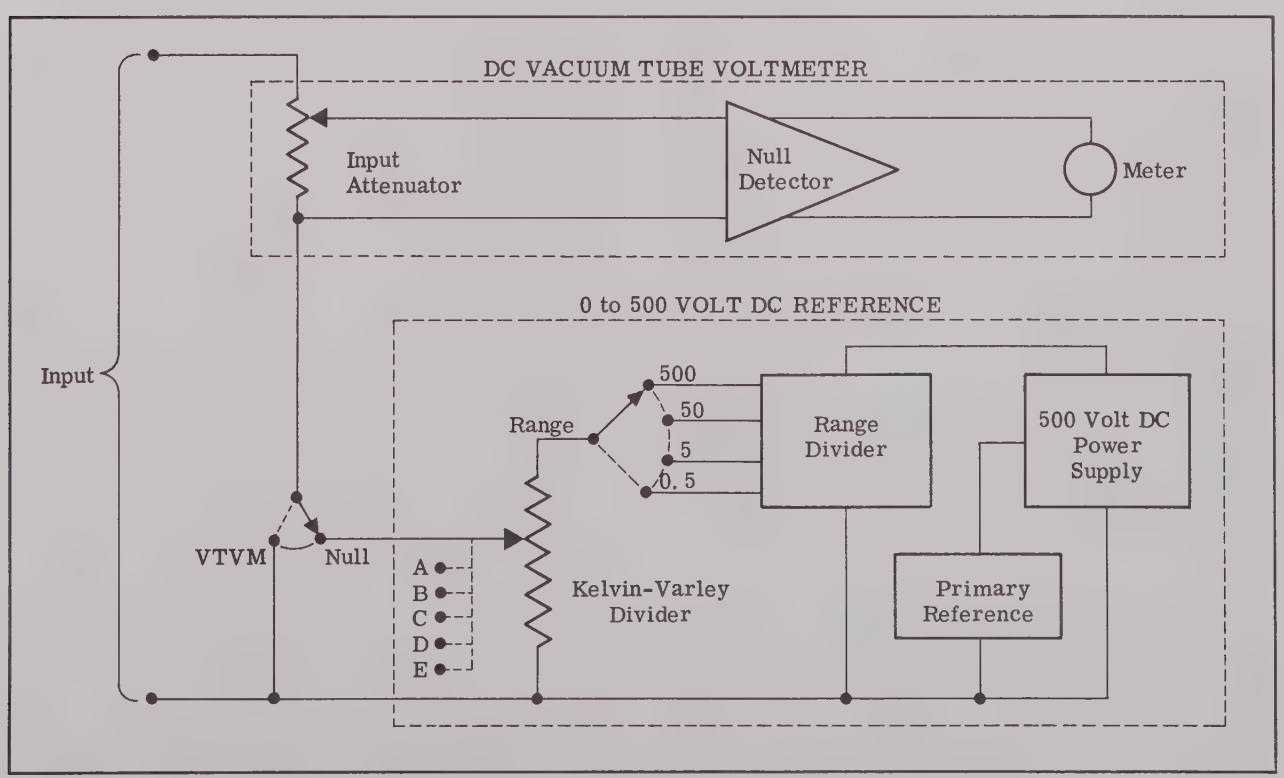


Figure 3-1. 825A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-2. DC VACUUM TUBE VOLTMETER

a. GENERAL. The DC vtvm is composed of an attenuator, a null detector, and meter. The heart of the DC vtvm is the null detector in which the DC signal is modulated, amplified, rectified, and finally filtered to produce a DC output. The null detector has a high amount of negative current feedback. This makes the output current approximately equal to the signal voltage divided by the impedance of the feedback network, regardless of the amplifier characteristics. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual stages due to aging and replacement. The output current from the null detector is indicated on a meter that has tautband suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is eliminated. The attenuator is used to reduce the voltage span of each range to a common range usable by the null detector to produce proper meter deflection.

b. NULL DETECTOR FOR 825A & 825A/AG SERIAL NOS. 123 TO 1705 AND 825AR & 825AR/AG SERIAL NOS. 123 TO 628. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, an 83 cycle electro mechanical chopper. This chopped voltage is amplified by V202A, V202B, and V203A before passing through cathode follower V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a DC current for the meter. The voltage developed across feedback network R220, R221, and R222 is proportional to the meter (output) current. When the chopper provides connection between contacts 1 and 9, this feedback voltage effectively reduces the magnitude of the voltage that is chopped and applied to the input of the amplifier. The impedance of the feedback network (R220, R221, and R222) is adjustable between 8.82 and 9.83 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 101.7 to 113.4 ua. However, there is a loss due to finite amplifier gain and filtering that leaves the output current around 100 ua which can be set accurately by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

c. NULL DETECTOR FOR 825A & 825A/AG SERIAL NUMBERS 1706 & ON, 825AR & 825AR/AG SERIAL NUMBERS 629 & ON. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by V201 and V202, a series-shunt photochopper. The photochoppers are driven by an astable multivibrator operating at 84 cycles to prevent interference from line frequency pickup. The chopped voltage is amplified by solid state amplifier Q201 through Q205 before being delivered to demodulator photocell V203. During half the chopper cycle, the output of the amplifier is clamped close to null detector common potential by V203 while during the other half the output is filtered by R221 and C211 to provide a DC output. To prevent loading of the chopper amplifier, especially at high temperatures, the filtered output is fed to unity gain amplifier Q206 and Q207 which supplies the necessary meter current. The voltage developed across feedback network R203, R204, and R205 is proportional to the meter (output) current. When DS202 illuminates V202, its resistance drops from about 50M to 5K and the amplifier input is equal to the feedback voltage. When DS203 illuminates V201, its resistance drops from about 50M to 5K and the amplifier input is equal to the output voltage of the input filter. The impedance of the feedback network (R203, R204, and R205) is adjustable between 9.28 and 10.5 ohms. Since the output current is approximately equal to the signal voltage divider by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 95.1 to 108 ua. The output current is adjusted to 100 ua during calibration by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

d. INPUT ATTENUATOR. In the vtvm mode, four positions on the vtvm attenuator selected by range switch section S2C provide the necessary reduction of the 500, 50, 5, and 0.5 volt ranges for proper null detector input. For this mode, the resistance of the attenuator and thus the input resistance of the 825A is 50 megohms (R301 through R310). In the differential mode, the voltage difference (unknown voltage minus reference voltage) is reduced by four positions on the vtvm attenuator selected by null switch section S3C and S3D to give full scale deflections corresponding to inputs of 10, 1, 0.1, and 0.01 volts. For full scale deflection corresponding to 0.001 volt, the voltage across the attenuator is fed directly to the null detector. Although the resistance of the vtvm attenuator is 10 megohms (R305 through R310) for the 10, 1, 0.1, and 0.01 volt null ranges and the one megohm (R306 through R310) for the 0.001 volt null range; this is not the input resistance of the 825A. The input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the input attenuator. The equation for input resistance can therefore be written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u\ R_a}{|E_u - E|} = \frac{E_s\ (R_a + R_s)}{|E_s - E|} - R_s$$

where:

R_{in} = input resistance of voltmeter

$E_u = E_s - I_u R_s$ = terminal voltage of unknown

I_u = current drawn from unknown

E_s = source voltage of unknown

R_s = source resistance of unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$| \ |$ = absolute value (magnitude only)

Since the reference voltage (E) is equal to the unknown voltage (E_u) and the source voltage (E_s) at null, no current is drawn from the unknown and the input resistance is therefore infinite.

e. NULL DETECTOR POWER SUPPLY FOR 825A & 825A/AG SERIAL NOS. 123 TO 1705, 825AR & 825 AR/AG SERIAL NUMBERS 123 TO 628. The B+ supply for the null detector is obtained from a half-wave rectifier consisting of diode CR201 and a filter network (C213A, R227, and C213B) that is regulated by an OA2 tube (V204) and series dropping resistor R230. Divider resistors R228, R229, R231, and R232 and diode CR202 provide a compensating voltage for the purpose of adjusting the null detector to zero with R232 when there is no signal input. Diode CR202 keeps one side of R232 at approximately -0.6 volts DC with respect to the null detector common.

f. The filament of V202 and the chopper drive unit require a stable supply. This is obtained by using a filtered half-wave rectifier (CR203 and C214) that drives a Darlington connection of Q201 and Q202. A divider string R234 and R235 uses the B+ supply to obtain approximately 11.8 volts for pin-5 of V202 while pin-4 is maintained approximately 0 volts through the emitter-base junctions of Q201 and Q202. Any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter-collector junction of Q201 so that the filament and chopper voltage remain stable. The filament supply for V203 is obtained from an ordinary 6.3 volt AC winding.

g. NULL DETECTOR POWER SUPPLY FOR 825A & 825A/AG SERIAL NOS. 1706 AND ON AND 825AR & 825AR/AG SERIAL NOS. 629 AND ON. The +18 volt and -18 volt supply for the null detector is obtained from a center tapped voltage doubler consisting of R229, CR202, CR203, C213, and C214.

h. EFFECT OF AC COMPONENTS. The only AC voltage component that will reduce the accuracy of the 825A is one that either saturates the null detector or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an AC component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper-amplifier will attenuate any AC component. The magnitude of the AC voltage appearing at the output of the filter depends on both its amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a hundred cycles. Below this, the filter may not attenuate the AC component enough. However, this is not as bad as it appears. A 60 cycle AC voltage that is 1% of the input voltage will cause an error of approximately 0.001% which is well within specifications. If AC components that affect accuracy are ever encountered, additional filtering as set forth in paragraph 2-9 will eliminate the problem.

i. GAIN AND ZERO ADJUSTMENTS. For 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825 AR/AG serial numbers 123 to 628, variable resistor R232 in the null detector power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. For later instruments, variable resistor R212 provides a means of adjusting the output current of the amplifier to zero when there is no input signal by utilizing the negative bias voltage on the emitter of Q201 and the positive bias voltage on the emitter of Q205. The gain of the amplifier is adjusted by means of R205 (R222 for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628) in the feedback circuit.

j. RECORDER OUTPUT. The recorder output is picked off divider string R224, R1, and R225 (R225, R1, and R226 for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628). Output level control R1 provides a means of adjusting the output voltage up to a maximum of at least 18 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

3-3. 0 to 500 VOLT REFERENCE

a. GENERAL. When the 825A is used for differential voltage measurements, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 0 to 500 volt reference. The 0 to 500 volt reference is composed of a well regulated 500 volt power supply, a range divider, and a Kelvin-Varley five decade attenuator. The output of the 500 volt power supply is applied directly to the Kelvin-Varley attenuator for the 500 volt DC range. In the 50, 5, and 0.5 volt DC ranges, the range divider reduces the voltage to 50, 5, and 0.5 volts before it is applied to the Kelvin-Varley attenuator. The Kelvin-Varley attenuator divides its input voltage (500, 50, 5, or 0.5 volts) into 50,000 equal increments any number of which may be selected by setting the five decades with the voltage readout dials. The output of the Kelvin-Varley attenuator, therefore, provides an extremely accurate reference voltage.

b. 500 VOLT POWER SUPPLY. The 500 volt power supply uses three diodes (CR101, CR102, and CR103) and a filter network (R105, R106, C101, and C102) to supply unregulated DC voltage to series passing tube V102. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R119, R120, R121, and R2) with the voltage from reference tube V104 in differential amplifier V105. The output of V105 is fed to differential amplifier V106 which drives the grid of series passing tube V102. The control action of the differential amplifiers continuously adjusts the voltage drop across the series passing tube so as to keep the sample voltage equal to the voltage of the reference

tube. Any difference in voltage, the error, is amplified by V105 and V106 and thus changes the voltage drop across V102 to maintain the output at 500 volts.

c. For proper operation a highly stable and accurate balance of amplification must be maintained between the two halves of differential amplifier V105. The filament supply for V105 must be regulated to maintain this balance. A filtered half-wave rectifier (CR104 and C106) drives a Darlington connection of Q101 and Q102. A divider string, R101 and R102, uses the plate of V104 to maintain approximately 6.3 volts on pin-9 of V105 while pin-4 and pin-5 are maintained at approximately 0 volts through the emitter-base junctions of Q101 and Q102. Thus any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter-collector junction of Q101 so that the filament voltage of V105 remains stable.

d. RANGE DIVIDER. In the 500 volt range the output of the 500 volt supply is passed directly to the Kelvin-Varley attenuator by range section S2F. In the 50, 5, and 0.5 volt positions, range resistors (R320 through R330) selected by section S2E divide the reference voltage to 50, 5, and 0.5 volts before it is switched to the Kelvin-Varley attenuator by section S2F.

e. KELVIN-VARLEY ATTENUATOR. The five Kelvin-Varley decade resistor strings R401 through R455 and associated voltage dials A through E (S6 through S10) provide a means of making the four precision voltages (500, 50, 5, and 0.5) adjustable. Note that each string, with the exception of the first, parallels two resistors of the preceding string. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the range switch in the 500 volt positions, a total voltage of 100 volts will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts across the wipers of S7, S8, and S9, respectively. Voltage dial E (S10) picks increments of 0.01 volt from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range. The Kelvin-Varley resistors are matched for both temperature coefficient and tolerance thus providing an overall attenuator accuracy of 0.005% absolute. With the null switch in any null range, the output of the Kelvin-Varley attenuator is connected in series with the vtvm attenuator thus providing the accurate 0 to 500 volts reference required.

f. ADJUSTMENTS. Variable resistor R121 is used during calibration to set the 500 volt supply to 500 volts with calibrate control R2 set at its center of rotation. This allows the reference supply to be adjusted to 500 volts by means of the calibrate control at any time deemed necessary. With the operate-calibrate switch held at calibrate, a fixed percentage of the 500 volt supply is compared to the precise potential of an internal standard cell or Zener diode (in the /AG models). Any difference in potential is fed to the null detector to give an indication on the meter so that the reference supply can be set with the calibrate control. The fixed percentage of the reference supply is set accurately during calibration by means of R318. The 50, 5, and 0.5 volt range resistor networks are set accurately during calibration by means of R323, R326, and R329.

3-4. POLARITY SWITCH

Because of the polarity switch S5, upper input post J1 should never be electrically connected to the 825A chassis, either at the 825A or at the source under measurement. As seen in figure 3-2, the polarity switch does not reverse the input posts. It reverses the meter and the internal reference supply. If the instrument did not contain a polarity switch, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the upper input binding post. This would ground the upper post and effectively place C1 (a 0.47 uf capacitor) across the input terminals. Even if C1 was disconnected, there would still be considerable capacitance across the input due to transformer winding capacitance and stray wiring capacitance. With this capacitance across the circuit being measured several problems would arise. The polarity switch provides equal convenience in measuring positive or negative voltages without the occurrence of these problems.

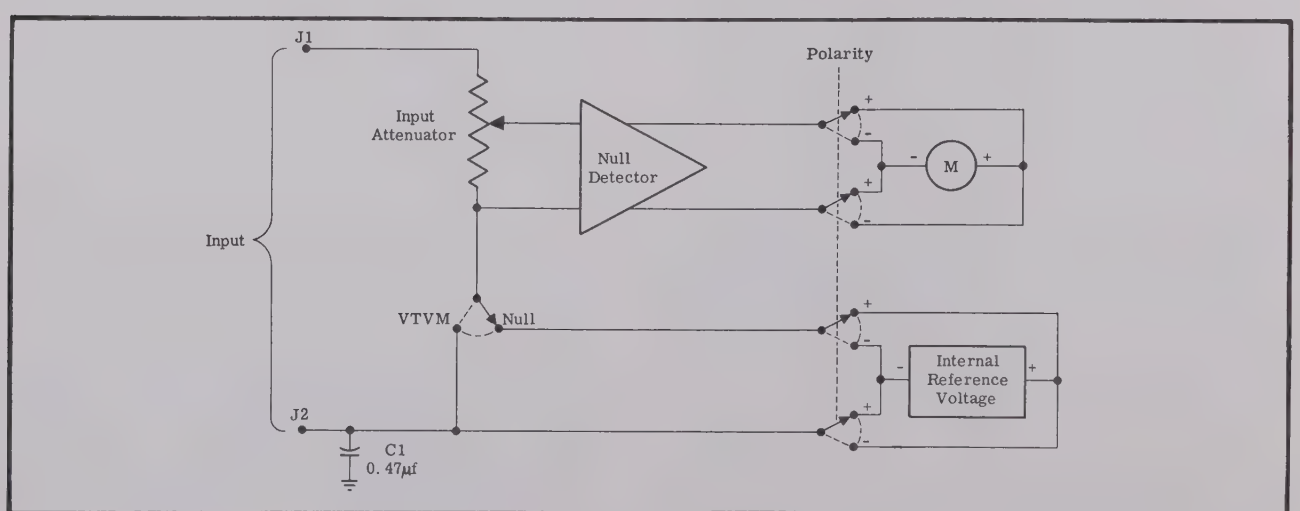


Figure 3-2. FUNCTION OF POLARITY SWITCH .

SECTION IV

MAINTENANCE

4-1. GENERAL

The 825A Differential DC Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is occasional cleaning, tube replacement, and calibration. Preventive maintenance consists only of preventing contamination of the chopper contacts (for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628) and any leakage as discussed in paragraph 4-2. A discussion of troubleshooting along with a troubleshooting chart, component location diagrams, and a tube voltage chart are provided in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PREVENTATIVE MAINTENANCE

a. LEAKAGE PREVENTION. The accuracy of the 825A is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards have been coated with Humi-Seal 1B12. The RANGE, NULL, OPERATE-CALIBRATE, and polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary, depending on environmental operating conditions.

b. To check for excessive electrical leakage, proceed as follows:

(1) Perform preliminary operation procedure as stated in paragraph 2-3.

(2) Set switches on 825A as follows:

RANGE	500
NULL	0.1
voltage readout dials	490.00

(3) Remove test leads from input posts.

(4) Excessive leakage is indicated if the meter deflects more than one-tenth of full scale.

c. To prevent excessive electrical leakage, proceed as follows:

(1) Blow the instrument out with low-pressure, clean, dry air to remove most accumulations of dust and foreign matter. Pay particular attention to the binding posts, binding post wiring, critical switches (NULL, RANGE, OPERATE-CALIBRATE, and polarity switches), and for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628, the two glass epoxy strips which insulate the null detector chassis from the main chassis.

(2) Clean the glass epoxy strips, binding posts, insulators, and front panel with a rag saturated in anhydrous denatured ethyl alcohol.

(3) When necessary, wash all exposed dielectric surfaces of the NULL, RANGE, OPERATE-CALIBRATE, and polarity switches with denatured alcohol using a small, stiff-bristled brush.

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any other methyl ethyl ketones, since they will react with the Lexan rotor on the CTS plastic switches.

(4) After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

d. CHOPPER CLEANING (FOR 825A & 825A/AG SERIAL NUMBERS 123 TO 1705 AND 825AR & 825AR/AG SERIAL NUMBERS 123 TO 628). All electromechanical choppers accumulate some foreign matter on the contacts over a period of time. This contact contamination only presents a problem in low level amplifiers of the type used in the 825A. It can cause the zero to shift to such an extent that the null detector can no longer be zeroed with VTVM ZERO ADJ control R232. To clean the chopper contacts, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case. On rack models, remove screws holding cover to instrument and set cover aside.

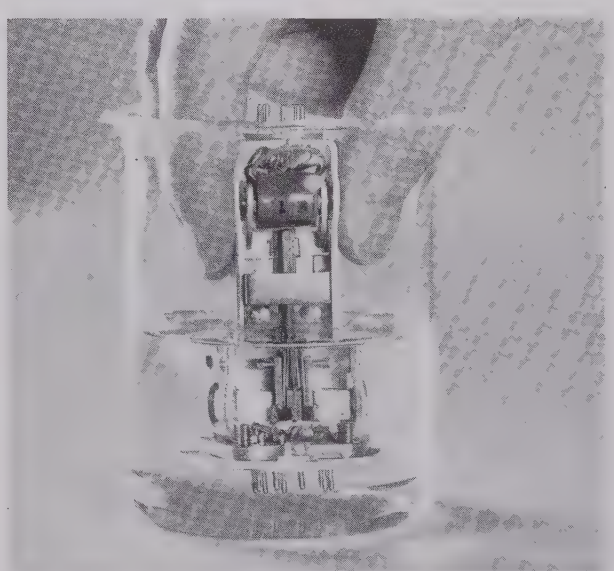


Figure 4-1. CHOPPER CLEANING

(2) Remove chopper from null detector chassis assembly and unplug chopper drive unit.
(3) Remove two screws at top of chopper and slide cover off.

CAUTION

Never touch the chopper contacts. It is also good practice not to handle any interior parts.

(4) Immerse chopper in clean denatured alcohol until the contacts are just under the surface (figure 4-1) and then agitate the chopper for about a minute.
(5) After chopper is thoroughly dry, replace chopper cover and install in instrument.

NOTE

If the chopper drive unit is unplugged while the instrument is on, the chopper drive unit will not operate when reassembled. However, the chopper drive unit will operate if the instrument is turned off and then turned back on.

(6) Adjust VTVM ZERO ADJ control R323 for zero meter deflection after a 20 minute warmup period.

4-3. TROUBLESHOOTING

a. GENERAL. To assist in localizing most trouble which might occur, a troubleshooting chart (figure 4-2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt DC reference supply evidenced by the continual need for resetting with the CALIBRATE control.	V104, V105, or V106 defective.	Check V104, V105, and V106 by replacement.
	One of the sampling string resistors (R119, R120, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt DC calibration.
	Drifting standard cell EMF possibly caused by previous shorting or inverting of the cell (825A and 825AR only).	Allow time for the standard cell to stabilize. Several hours should be sufficient.
Cannot calibrate 500 volt DC reference supply.	Excessive aging of V104.	Check V104 by replacement.
Meter cannot be brought to zero with CALIBRATE control.	Out of calibration.	Recalibrate per paragraph 4-4.
	One or more resistors in 500 volt DC sampling string has shifted in value.	Recalibrate per paragraph 4-4 and observe stability for 48 hours. If 500 volt DC reference supply remains stable replacement of resistor is unnecessary.
	Standard cell EMF has shifted (825A and 825AR only).	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R325 or R327 has shifted; in the 0.5 volt range, R328 or R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320 or R321 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.

Figure 4-2. TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Measure the voltage drop across each Kelvin-Varley resistor with another John Fluke Differential Voltmeter. Begin by setting RANGE switch to 500 volts and the voltage readout dials to 499.910. Reference to the schematic diagram will show that there should be 100, 10, 1, 0.1, and 0.01 volts respectively across each resistor of the A, B, C, D, and E decades, except for the two resistors of each decade that are paralleled by the following decade. Across these two resistors, there should be 50, 0.5, and 0.05 volts, respectively. Voltage measurements should be within 0.01% of each other. Remember that if one resistor in a decade has increased or decreased appreciably, the voltage drop across all other resistors in the decade will be slightly affected also.
Instrument is out of specifications on all ranges.	Resistors R306, R307, R308 or R309 out of tolerance.	Check and replace faulty resistor.
Meter rattle, drift, or error is observed on all null ranges.	V202, V203, or V204 faulty. Chopper G1 faulty. 825A & A/AG 123 to 1705 825AR & AR/AG 123 to 628	Check V202, V203, and V204 by replacement. Clean or replace chopper.
	Moisture or dirt on printed circuit boards or switches.	Clean instrument.

Figure 4-2. TROUBLESHOOTING (Sheet 2 of 2)

lists the causes and remedies for a number of symptoms. Since failure of the 825A is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the 825A is conservatively designed and should require very infrequent tube replacement. At certain times, a check of the operating level voltages of the tubes (figure 4-3) and transistors (figure 4-4) is also useful. As an aid to troubleshooting, all components may be located by referring to the figures shown in Section V. An understanding of the theory of operation (Section III) and frequent reference to the functional schematic will be of great value in troubleshooting.

WARNING

Use extreme care when working inside the instrument while it is on. The null detector assembly and all components thereon will be at a voltage close to that indicated by the voltage readout dials.

b. TUBE REPLACEMENT. Many differential amplifier circuits are critical with respect to the balance between halves of differential amplifier tubes. This is especially true of the first stage of amplification. However, the 825A is designed with the ability to use any 12AX7 for V104 and V105 that meets standard EIA (Electronics Industries Association) characteristics. Some output voltage drift of the 500 volt reference supply may be noted for the first few hours of operation. This drift will, in most cases, decrease to a small value after the tube has aged a bit. Occasionally a tube with a contaminated grid or extremely poor balance between halves will be found. This tube should be discarded. When replacing reference tube V104, the new tube should be aged at least 150 hours to realize the high order of stability inherent in the 825A. A tube that has been aged may be obtained by ordering an OG3-2 (116616) from Fluke.

c. Replacement of tubes will not normally necessitate complete recalibration of the 825A. If V202 or V203 is replaced for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628, calibrate the null detector as set forth in paragraphs 4-4b and 4-4c. Replacement of V102, V104, V105, or V106 will necessitate calibration of the reference supply per paragraphs 4-4b and 4-4d.

d. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board (or on the null detector chassis for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628), proceed as follows:

(1) Clean soldered area around component with Methyl Ethyl Keytone.
(2) Remove part and install new component.
(3) Remove flux with du Pont Freon PC.
(4) Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.
(5) Coat any uncoated areas around R301 through R310 on the Range Resistor Printed Circuit Board and on 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628 around the input to the null detector chassis (tube V202, 5751, and chopper) with Humi-Seal 1B12.
(6) If a component at the input to the transistorized null detector (825A & 825A/AG serial numbers 1706 and on and 825AR & 825AR/AG serial numbers 629 and on) is replaced, make sure that all leads at the input wire - R201 junction, the R201 - R202 - DS201 - C201 junction, and the R202 - C202 - V201 junction are in physical contact with each other. Otherwise, thermal voltages may result that will degrade the performance of the instrument.

e. KELVIN-VARLEY RESISTOR REPLACEMENT. All the resistors of the first three decades (R401 to R406, R407 to R417, and R418 to R428) are matched and these three decades are matched for each instrument. If it becomes necessary to replace a Kelvin-Varley resistor, the instrument model and serial number as marked on the name plate and all information stamped on the resistor must be sent to Fluke along with the purchase order for the particular resistor needed. This ensures that a resistor compatible with the matched resistor group within the instrument is used. The Kelvin-Varley resistors are very stable and precise; resistance is clearly defined; therefore, they must be handled with care. This is especially true of the varnished-dipped-card resistors.

CAUTION

Pick up card resistors between ends of card. Never touch the wire on the cards as damage to the resistor could possibly result.

f. STANDARD CELL PROBLEMS. The standard cell in the Model 825A and 825AR deserves special consideration if it is suspected of being faulty:
(1) The standard cell used is a miniature unsaturated cell which has excellent long term stability and negligible temperature-voltage hysteresis. (Temperature-voltage hysteresis is the erratic behavior of the voltage while the cell is coming to equilibrium following a change in temperature). Under normal conditions this cell should last from 8 to 15 years. In rare instances, failure has occurred in less than 2 years. End of life is usually marked by an increase in temperature-voltage hysteresis effect. That is, reading errors in excess of 0.01% will result when the same voltage is read with the 825A hot and cold. The emf of different cells may vary as much as 0.05% and each instrument is calibrated to its own particular standard cell. Thus, when the standard cell is replaced, the 825A reference supply must be recalibrated as in paragraph 4-4d.
(2) Failure of the standard cell may occur if subjected to below freezing temperature. The electrolyte will start to freeze at about 5°F and operation below 32°F is definitely not recommended. The life of the cell will also be greater if the 825A is not operated at elevated temperature. The 8 to 15 year figure holds for operation of the instrument at normal room temperature, 72(±3)°F.
(3) The emf of the standard cell will change if the cell has been inverted, or if the cell has been inadvertently short-circuited. If the emf has changed, the 825A will naturally be out of calibration on all ranges. In either case, the cell will return to its original emf.

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V102, 6BQ5	No Conn.	495	500 (±3%)	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn	680 to 730
V104, OG3	.85 (±3%)	0	Int. Conn.	0	85 (±3%)	Int. Conn.	0	No Pin	No Pin
V105, 12AX7	217	84	86	Heater voltage 6.0 volts dc		217	84	86	See Pin 4 & 5
V106, 12AX7	495	217	220	Heater voltage 6.3 volts ac		500	217	220	
V202, 5751 (825A & A/AG 123 to 1705)	60	-	0	Heater voltage 12 volts dc		100	-	1.5	No Conn.
V203, 6AW8 (825AR & AR/AG 123 to 628)	47	45	140	Heater voltage 6.3 volts ac		0.7	-	25	50
V204, OA2 (825AR & AR/AG 123 to 628)	150	0	Int. Conn.	0	150	Int. Conn.	0	No Pin	No Pin

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM; (c) all voltage readout dials set to zero; (d) line voltage at 115/230 volts, 50 - 440 cycles; and (e) all measurements made with a VTVM from negative binding post to specified terminal; (f) all voltages may vary by 20% unless otherwise indicated.

Figure 4-3. TUBE VOLTAGE CHART

TRANSISTOR	Q1	Q2	Q3	Q201	Q202	Q203	Q204	Q205	Q206	Q207
E	3.0	9.3	9.7	-0.45	-0.45	-0.45	0	0.58	-0.54	17.2
B	3.5	9.2	9.3	0	0	0	0.51	0.98	0	16.5
C	9.2	5.8	5.8	0	0	9.2	0.98	7.5	16.5	0

This chart is to be used under the following conditions: (a) voltages for transistors Q201 to Q207 apply to 825A & 825A/AG serial numbers 1706 and on and 825AR & 825AR/AG serial numbers 629 and on; (b) RANGE switch set to 500; (c) NULL switch set to VTVM; (d) all voltage readout dials set to zero; (e) polarity switch set to +; (f) line voltage at 115/230 volts, 50-440 cycles; (g) all measurements made with vtvm from negative binding post to specified terminal; and (h) all voltages may vary by 20% unless otherwise indicated.

Figure 4-4. TRANSISTOR VOLTAGE CHART

If the cell were inverted or shorted for only a few seconds, the 825A should be able to measure voltages within specifications after several hours recovery time.

g. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt pilot bulbs. To prolong their life these bulbs are operated from a 5 volt transformer winding. However, these bulbs do occasionally fail. To replace, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case.

(2) Remove four screws that hold front panel assembly to chassis.

(3) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(4) Remove screws holding range resistor printed circuit board and Kelvin-Varley printed circuit board to front panel assembly.

(5) Push these printed circuit boards aside enough to allow access to pilot light holders.

(6) Remove pilot light holder from bracket by applying pressure to each side of holder.

(7) Remove cardboard light shield and replace pilot light.

(8) On rack models, remove screws holding cover to instrument and set cover aside.

(9) Remove pilot light holder from bracket by applying pressure to each side of holder.

(10) Remove cardboard light shield and replace pilot light.

h. CHOPPER DRIVE FREQUENCY ADJUSTMENT FOR 825A & 825A/AG SERIAL NUMBERS 1706 AND ON, 825 AR & 825AR/AG SERIAL NUMBERS 629 AND ON. The chopper drive frequency needs to be adjusted only a few times during the life of the instrument. As neon lamps DS202 and DS203 age, their voltage will change slightly and cause the frequency to shift. This is especially true during the early life of the instrument. However, the chopper drive frequency needs to be adjusted only if a beating effect appears on the meter due to line frequency interference. Proceed as follows:

(1) Set controls on voltmeter as follows:

POLARITY	+ (positive)
NULL	.001
all voltage readout dials	0 (zero)

(2) Connect an oscillator to input of voltmeter through a capacitor of about 0.1 microfarads.

(3) Set oscillator for an output of 84 cycles.

(4) Adjust R226 until meter begins to beat and then adjust for zero beat.

4-4. CALIBRATION

a. GENERAL. The 825A can be calibrated as often as deemed necessary. However, it is recommended that the instrument be calibrated every 6 months. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more frequently. Calibration should be accomplished in a draft-free area with ambient temperature of 72 (±3)° for maximum accuracy under typical laboratory operating conditions. Figure 4-5 lists the type of test equipment required for calibration along with the applicable specifications and recommended instruments. All controls may be located with the aid of figure 4-6.

b. PRELIMINARY CALIBRATION PROCEDURES

(1) Set 825A meter to zero with mechanical zero control

(2) Set switches on 825A as follows:

RANGE	500
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)

(3) Set power switch to ON and allow 825A to warmup to equilibrium temperature (about 1/2 hour) inside its case. Meanwhile, proceed with step (4).

(4) Set up necessary equipment to provide DC voltages of 500, 50, 5, and 0.5 volts DC with an accuracy of 0.005%. Proceed as follows: turn on all test equipment and allow it to warm to equilibrium temperature (about 1/2 hour); set proper standard cell voltage on divider; apply 500 volts DC into divider from power supply; set divider to 500 and zero galvanometer by varying output of power supply; voltages of 500, 50, 5, and 0.5 volts DC are made available at output posts by merely changing position of voltage selector switch on voltage divider.

(5) Connect chassis ground binding post to line ground.

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
DC CALIBRATION:	
Fluke 301C or 301E Power Supply	The equipment used must provide 500, 50, 5, and 0.5 volts with accuracy of 0.005%.
Saturated standard cell bank with an accuracy of ±0.0025%	
Voltage reference divider having division ratios of 1, 10, 100, and 1000 with an accuracy of ±0.0025%	
Galvanometer suitable for use with above voltage reference divider	

Figure 4-5. CALIBRATION EQUIPMENT

c. NULL DETECTOR CALIBRATION

(1) Perform preliminary calibration procedure as stated in paragraph 4-4b.

(2) Adjust null detector ZERO ADJ control R212 (R232 for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628) until meter indicates zero.

(3) Apply 500 volts DC (±0.005%) to voltmeter.

(4) Adjust VTVM GAIN ADJ control R205 (R222 for 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628) for full scale deflection.

d. 500 VDC REFERENCE SUPPLY CALIBRATION

(1) Perform preliminary calibration procedure as stated in paragraph 4-4b.

(2) Center CALIBRATE control at its center of rotation.

(3) Set NULL switch to 10 and voltage readout dials to 499.910.

(4) Apply 500 volts DC (±0.005%) to voltmeter.

(5) Adjust 500V ADJ control R121 for a null.

(6) Set NULL switch to 0.1 volt.

(7) Null meter by adjusting CALIBRATE control.

(8) Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF CAL ADJ control R318.

e. RANGE DIVIDER CALIBRATION

(1) Perform preliminary calibration procedure as stated in paragraph 4-4b.

(2) Set switches on 825A as follows:

RANGE	50
NULL	0.01
voltage readout dials	49.9910

(3) Apply 50 volts DC (±0.005%) to voltmeter.

(4) Null 825A meter by adjusting 50V DC ADJ control R323.

(5) Set RANGE switch to 5 volts.

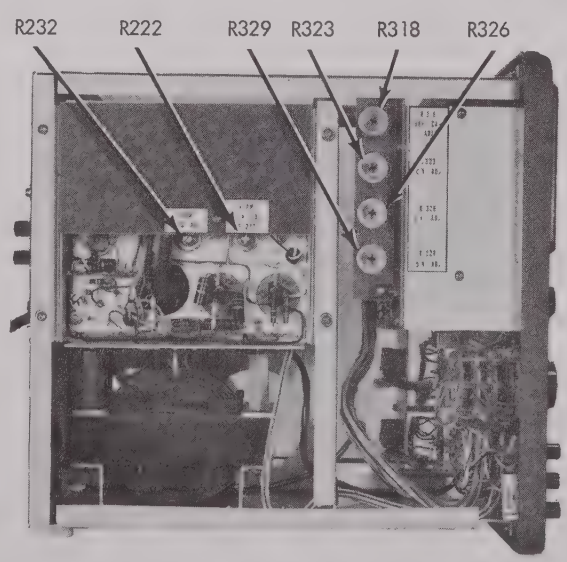
(6) Apply 5 volts DC (±0.005%) to voltmeter.

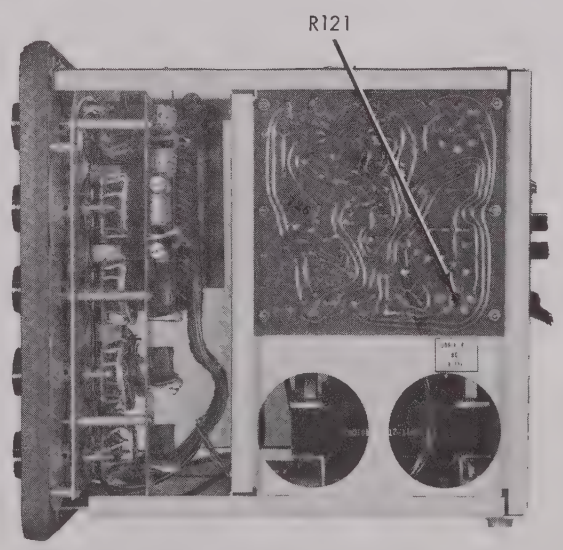
(7) Null 825A meter by adjusting 5V DC ADJ control R326.

(8) Set RANGE switch to 0.5 volts.

(9) Apply 0.5 volts DC (±0.005%) to voltmeter.

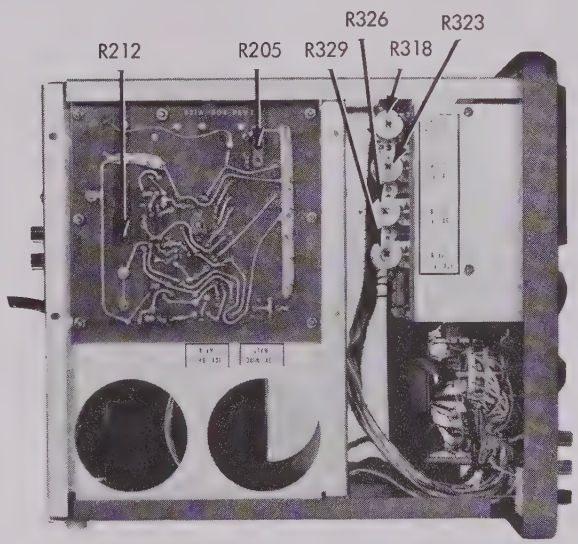
(10) Null 825A meter by adjusting 0.5V DC ADJ control R329.

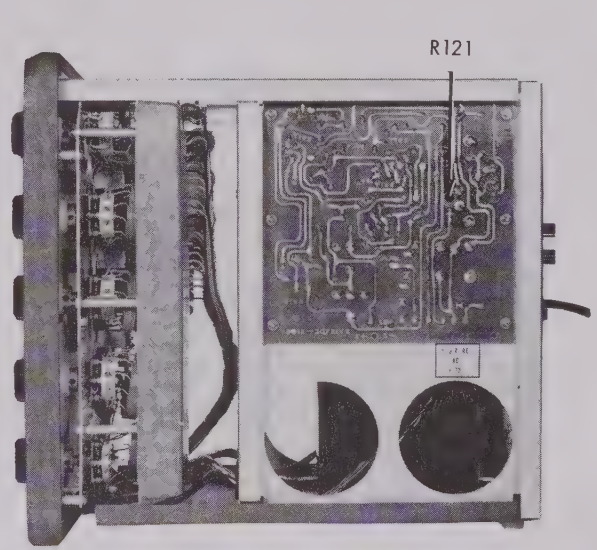




825A and 825A/AG serial numbers 123 to 1705
825AR and 825AR/AG serial numbers 123 to 628

Figure 4-6. ADJUSTMENT LOCATIONS (sheet 1 of 2)





825A and 825A/AG serial numbers 1706 and above
825AR and 825AR/AG serial numbers 629 and above

Figure 4-6. ADJUSTMENT LOCATIONS (sheet 2 of 2)

SECTION V
LIST OF REPLACEABLE PARTS

5-1. GENERAL

a. The following six assembly lists describe all normally replaceable parts of the Model 825A, 825AR, 825A/AG, and 825AR/AG Differential DC Voltmeters. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

b. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 825A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

5-2. HOW TO OBTAIN PARTS

a. Standard components have been used whenever possible. Thus, most parts may be obtained locally. However, special components are used in some instances. All parts manufactured or altered by Fluke and all parts for which Fluke controls the design are designated by an asterisk preceding the Fluke stock number. All structural parts and special parts should be purchased from your local Fluke representative or from the factory.

b. When ordering parts always include:

(1) Reference designation, description, and Fluke stock number.

(2) Instrument model and serial number.

(3) Most structural parts are not listed. In this case, give complete description, function, and location for the part.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Final Assembly		
	(Cabinet model, standard cell option)	*825A	
	(Rack model, standard cell option)	*825AR	
	(Cabinet model, zener diode option)	*825A/AG	
	(Rack model, zener diode option)	*825AR/AG	
	Front Panel Assembly (See figure 5-2)		
	Model 825A	*138693	
	Model 825AR	*138719	
	Model 825A/AG	*138701	
	Model 825AR/AG	*138727	
	Reference Supply Board Assembly (See figure 5-3)	*801B-401	C
		*135038	D
	Null Detector Chassis Assembly (See figure 5-4)	*125229	AB
		*168807	AC
	Range Resistor Board Assembly (See figure 5-5)		
	Model 825A	*121145	M
		*152876	N
	Model 825AR	*121202	M
		*147074	N
	Model 825A/AG	*121152	M
		*153494	N
	Model 825AR/AG	*121228	M
		*153502	N
	Kelvin-Varley Resistor Board Assembly (See figure 5-6)	*134775	
C2	Capacitor, electrolytic, 15 uf -10/+150%, 6V	105700	E
CR1, CR2	Diode, silicon, 300 ma, 400 PIV	116111	E
F1	Fuse, 1 ampere, slow-blowing (for 115 volt operation)	109272	
	Fuse, 1/2 ampere, slow-blowing (for 230 volt operation)	109322	
J4, J5	Binding post, black	101204	I
	Binding post, red	104158	J
	Binding post insulator, red (4 used)	101188	G
	Binding post insulator, dual, black (2 used)	135053	H

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R1	Resistor, variable wirewound, 5K ±10%, 2W	111583	
R3	Resistor, precision power (825A/AG and 825AR/AG. Optimum value is selected at factory to match Zener diode. When ordering, include information listed on Range Resistor Board decal).		
T1	Transformer, power	*801B-651	C
	Transformer, power	*135012	AD
		*161216	AC
	Line cord, 3 wire	102822	
	Rubber foot	101253	
	Case Assembly (Cabinet model)	*134940	
	Handle, flexible black vinyl, 5-1/2" (Cabinet model)	407-101	

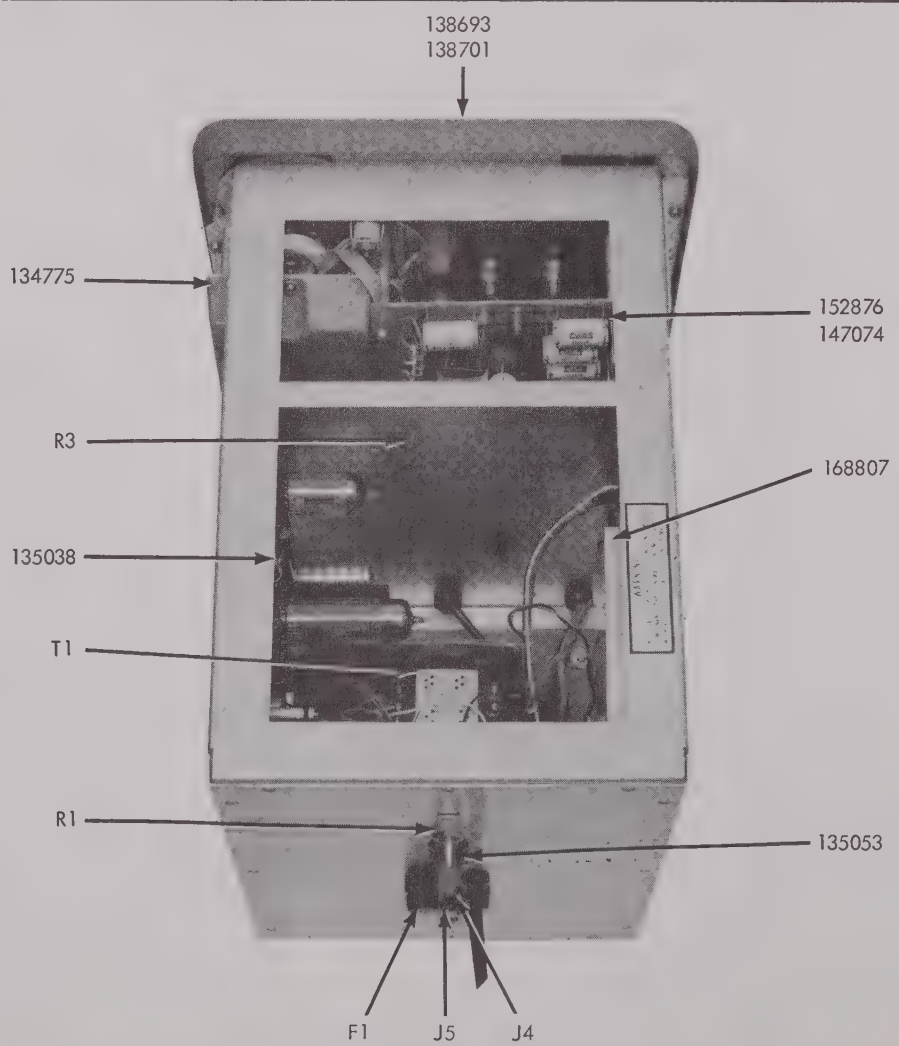


Figure 5-1. FINAL ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly		
	Model 825A	*138693	
	Model 825AR	*138719	
	Model 825A/AG	*138701	
	Model 825AR/AG	*138727	
B1	Standard cell (825A and 825AR)	135160	
C1	Capacitor, plastic, 0.47 uf ±10%, 600V	105494	
DS1, DS2	Lamps, decimal	102855	
DS3, DS4	Light holder	100131	
	Light shield	101428	
	Light lens	103440	
J1, J2, J3	Binding post, black	101204	G
J2	Binding post, black	101204	H
J1, J3	Binding post, red	104158	H
	Binding post insulator, red (4 used)	101188	G
	Binding post insulator, dual, black (2 used)	135053	H
	Binding post spacer	101212	
M1	Meter, 100-0-100 microamp (M32, M49, and 111211 are interchangeable)	*M32, M49, or 111211	
R2	Resistor, variable, dual section wirewound 1K and 100 ohm ±10%, 2W	112714	
S1	Switch, power	114850	
S2	Switch, range	*801B-804	A
		*120642	B
S3	Switch, null	*825A-801	A
		*121293	B
S4	Switch, operate-calibrate	*801B-807	A
		*134973	B
S5	Switch, polarity	*801B-806	A
		*134965	B
S6	Switch, voltage dial A	*801B-801	A
		*134817	B
S7, S8, S9	Switch, voltage dials B, C, and D	*801B-802	A
		*134841	B
S10	Switch, voltage dial E	*801B-803	A
		*134825	B
	Knob	101287	AE
		188524	AF
	Knob	101121	AE
		171660	AF
	Knob	101311	AE
		188524	AF
	Knob	103044	AE
		170068	AF
	Voltage dial plates (cabinet model)	107029	
	(rack model)	107011	

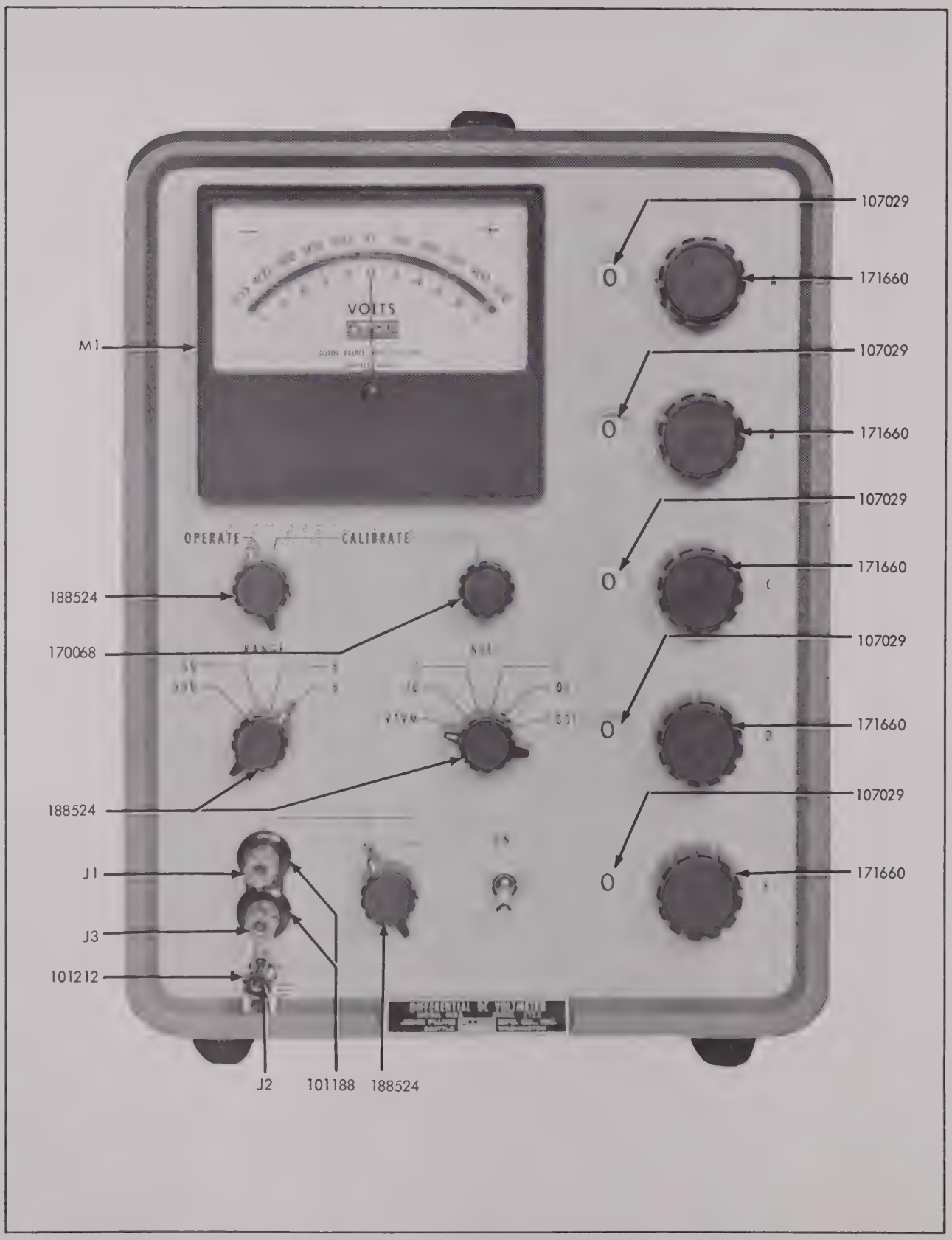


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 1 of 2)

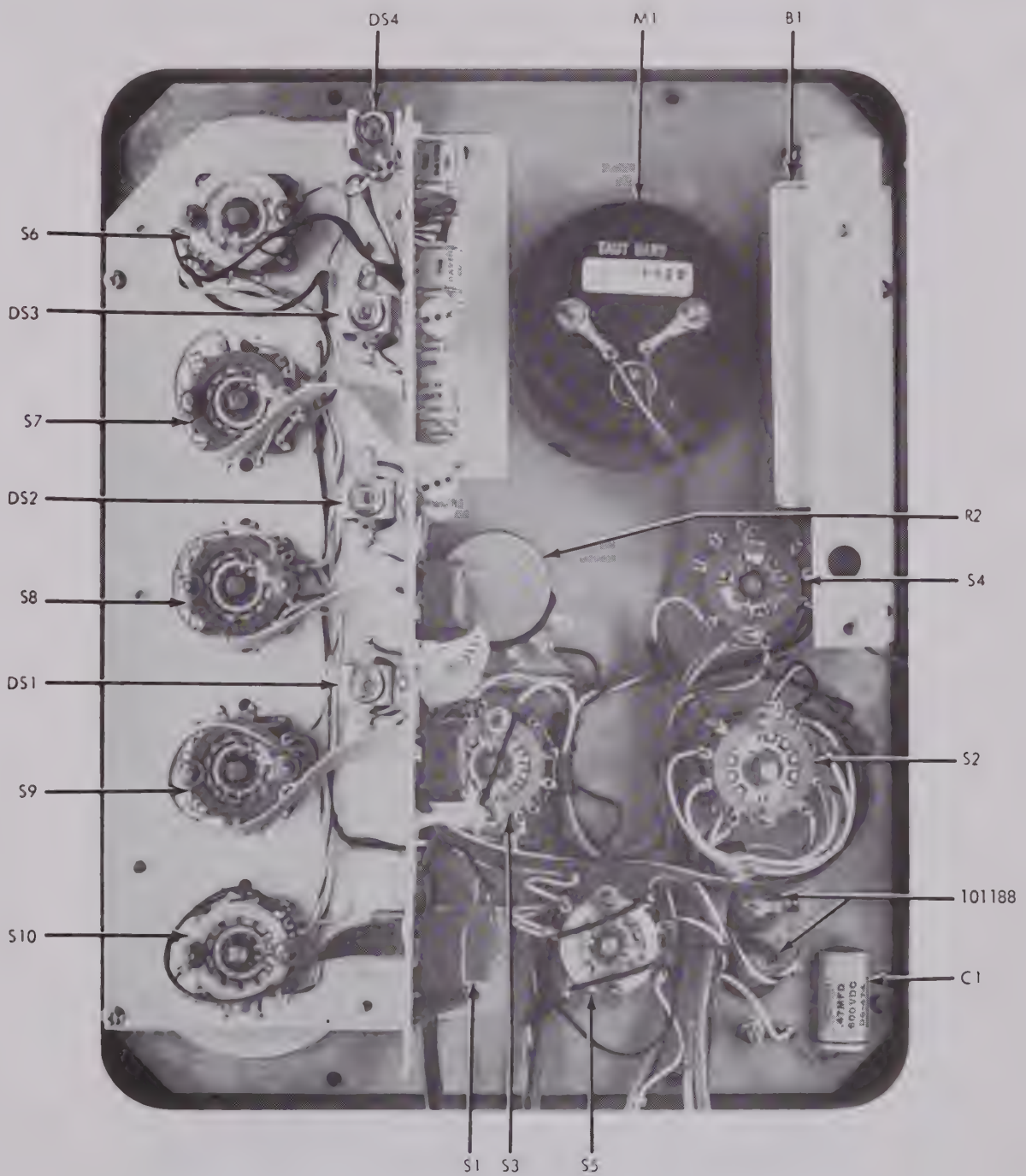


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Supply Board Assembly without Tubes	*801B-401 *135038	C D
C101, C102	Capacitor, electrolytic, 20 uf -10/+100%, 500V	105932	
C103	Capacitor, paper, 0.1 uf ±20%, 400 V	105312	
C104	Capacitor, plastic, 0.033 uf ±20%, 600V	105916	
C105	Capacitor, plastic, 0.1 uf ±20%, 600V	105833	
C106	Capacitor, electrolytic, 1500 uf -10/+150%, 16V	106666	D
CR101 thru CR103	Diode, silicon, 0.750 Amp, 600 PIV	112680	C
CR101 thru CR104	Diode, silicon, 0.750 Amp, 600 PIV Diode, silicon, 0.750 Amp, 600 PIV	112680 112383	Y V
Q101	Transistor, germanium, PNP,	*116707	D
Q102	Transistor, germanium, PNP, 2N1372	116129	D
R101	Resistor, wirewound, 10Ω, ±5%, 10W Resistor, deposited carbon, 5K ±1%, 1/2W	112300 107110	C D
R102	Resistor, composition, 1 Meg ±10%, 1/2W Resistor, deposited carbon, 62K ±1%, 1/2W	108134 107722	C D
R103	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R104	Resistor, composition, 220K ±10%, 1/2W	108217	
R105, R106	Resistor, composition, 270K ±10%, 1W	109512	
R107	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R108	Resistor, composition, 15 Meg ±10%, 1/2W	108647	
R109	Resistor, composition, 10 Meg ±10%, 1/2W	108142	
R110	Resistor, composition, 100K ±10%, 1W	109397	
R111	Resistor, wirewound, 140K ±3%, 10W	112417	
R112	Resistor, composition, 100K ±10%, 1/2W	108126	
R113	Resistor, composition, 560K ±10%, 1W	109678	
R114	Resistor, composition, 220K ±10%, 1/2W	108217	
R115	Resistor, composition, 330Ω ±10%, 1/2W	108589	
R116	Resistor, composition, 220K ±10%, 1W	109652	
R117	Resistor, composition, 82K ±10%, 1/2W	108498	
R118	Resistor, composition, 560K ±10%, 1W	109678	
R119	Resistor, wirewound, 386K ±0.5%, 1W	112482	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R120	Resistor, wirewound, 76K ±0.5%, 1/2W	111948	
R121	Resistor, variable, wirewound, 5K ±20%, 1-1/4W	111609	
V101	Vacuum tube, filament regulator, 9-7	116608	C
V102	Vacuum tube, pentode, EL84/6BQ5	116616	
V103	Lamp, neon glow, NE2E Lamp, neon glow, NE83	100347 170167	Z AA
V104	Vacuum tube, voltage reference, OG3-2	*116749	
V105, V106	Vaccum tube, duo triode, 12AX7	115956	

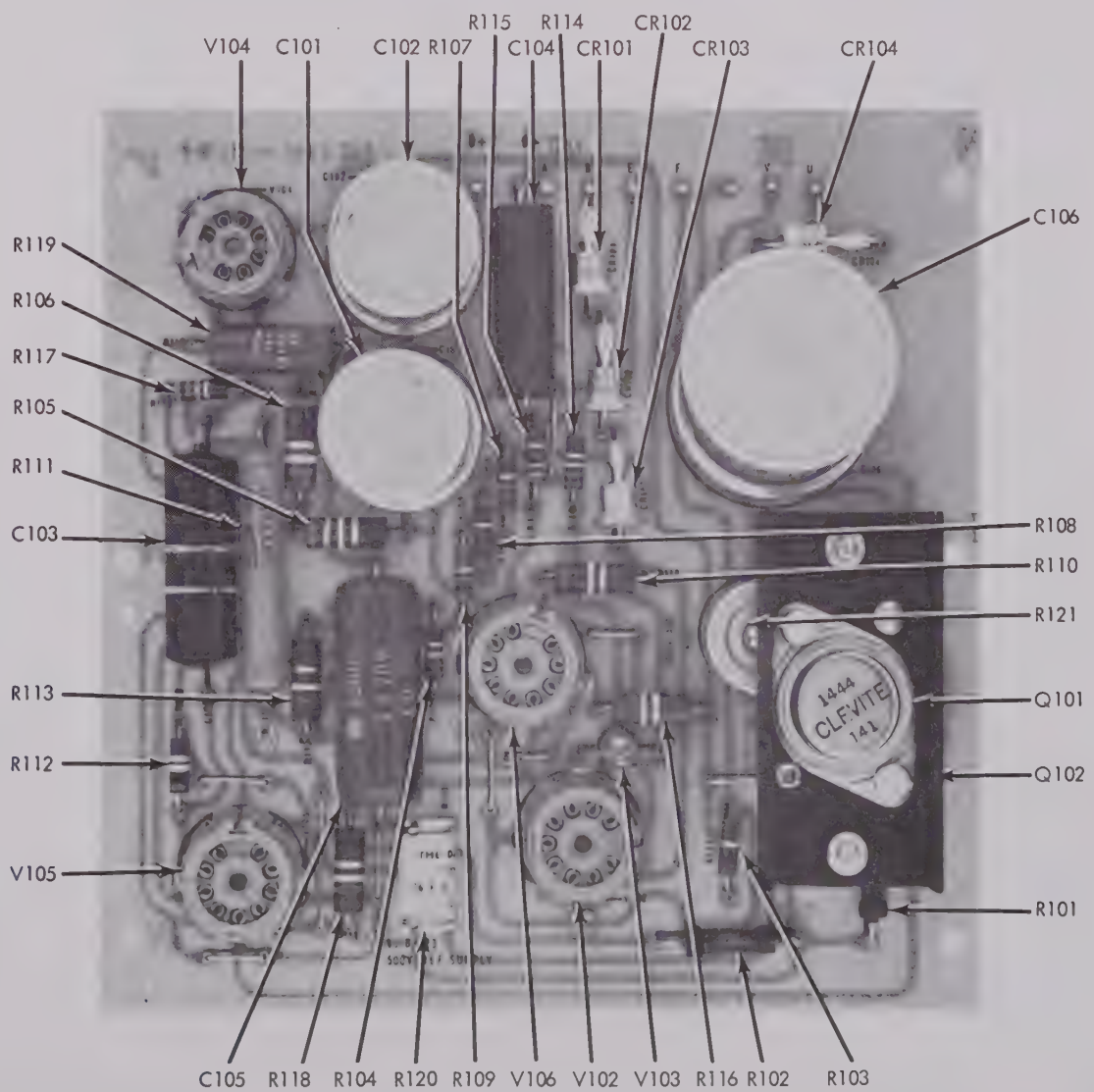


Figure 5-3. REFERENCE SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to 825A & 825A/AG serial numbers 123 to 1705 and 825AR & 825AR/AG serial numbers 123 to 628.		—
	Null Detector Chassis Assembly without tubes	*121160	
C201, C202	Capacitor, plastic, 0.1 uf ±20%, 100V	106526	
C203	Capacitor, paper, 0.047 uf ±20%, 400V	105718	
C204 ABC	Capacitor, electrolytic, 40-20-20 uf -10/+100%, 250V	106542	
C205	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	K L
C206	Capacitor, electrolytic, 100 uf -10/+100%, 3V	106534	
C207	Capacitor, ceramic, 0.005 uf ±20%, 500V	105650	
C208	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	K L
C209	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C210	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	K L
C211	Capacitor, electrolytic, 5 uf -10/+100%, 50V	106500	
C212	Capacitor, electrolytic, 500 uf -10/+100%, 3V	106328	
C213 AB	Capacitor, electrolytic, 20-20 uf -10/+50%, 450V	105064	
C214	Capacitor, electrolytic, 2000 uf -10/+100%, 25V	105171	
C215	Capacitor, electrolytic, 30 uf -10/+100%, 15V	106492	
C216	Capacitor, electrolytic, 15 uf -10/+150%, 6V	105700	F
CR201	Diode, silicon, 0.75 Amp, 600 PIV Diode, silicon, 0.75 Amp, 600 PIV	112680 112383	U V
CR202	Diode, silicon, type 2E4, 300 ma, 400 PIV	116111	
CR203	Diode, silicon, 0.75 Amp, 600 PIV Diode, silicon, 0.75 Amp, 600 PIV	112680 112383	U V
CR204, CR205	Diode, silicon, 1 Amp, 100 PIV	116111	F
G1	Chopper, electromechanical, 94 cycle, SPDT	103176	
	Chopper drive unit, 96 cycle	103184	
Q201	Transistor, germanium PNP, special purpose 2N301W	*116707	
Q202	Transistor, germanium PNP, 2N1372	116129	
R201 thru R203	Resistor, composition, 820K ±10%, 1/2W	108357	
R204	Resistor, composition, 2.2 Meg ±10%, 1/2W	108225	
R205	Resistor, composition, 22K ±10%, 1/2W	108209	
R206	Resistor, composition, 150K ±10%, 1/2W	108167	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R207	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R208	Resistor, composition, 10 Meg ±10%, 1/2W	108142	
R209	Resistor, composition, 10 K ±10%, 1/2W	108118	
R210	Resistor, composition, 220K ±10%, 1/2W	108217	
R211, R212	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R213	Resistor, composition, 180 K ±10%, 1/2W	108431	
R214	Resistor, composition, 1 K ±10%, 1/2W	108563	
R215	Resistor, composition, 3.3 Meg ±10%, 1/2W	108282	
R216	Resistor, composition, 1.5 Meg ±10%, 1/2W	108175	
R217	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R218	Resistor, composition, 22 K ±10%, 1/2W	108209	
R219	Resistor, composition, 220Ω ±10%, 1/2W	108191	
R220	Resistor, carbon film, 10Ω ±1%, 1/2W	107789	
R221	Resistor, carbon film, 75Ω ±1%, 1/2W	107045	
R222	Resistor, variable wirewound, 500Ω ±10%, 2W	111773	
R223, R224	Resistor, composition, 1.8 K ±10%, 1/2W	108860	
R225, R226	Resistor, composition, 47 K ±10%, 2W	110015	
R227	Resistor, composition, 2.2 K ±10%, 2W (This resistor replaces 2.7K resistor, HB2721, used in earlier models. If replacement is required, use HB2221.)	109967	
R228	Resistor, composition, 560K ±10%, 1/2W	108795	
R229	Resistor, composition, 560Ω ±10%, 1/2W	108316	
R230	Resistor, composition, 2.2 K ±10%, 2W (This resistor replaces 2.7 K resistor, HB2721, used in earlier models. If replacement is required, use HB2221.)	109967	
R231	Resistor, composition, 180 K ±10%, 1/2W	108431	
R232	Resistor, variable wirewound, 10 K ±20%, 2W	111617	
R233	Resistor, composition,100 K ±10%, 1/2W	108126	
R234	Resistor, carbon film, 2.7 K ±1%, 1/2W	107276	
R235	Resistor, carbon film, 31.6 K ±1%, 1W	107797	
R236	Resistor, composition, 22 K ±10%, 1/2W (may be omitted)	108209	
V201	Lamp, neon glow, type NE2E, 1/10W	100347	
V202	Vacuum tube, duo triode, 5751	116657	
V203	Vacuum tube, triode-pentode, 6AW8A	116434	
V204	Vacuum tube, voltage reference, OA2	115873	
	Vacuum tube shield	101808	
	Vacuum tube clamp, 2 inches high	102178	

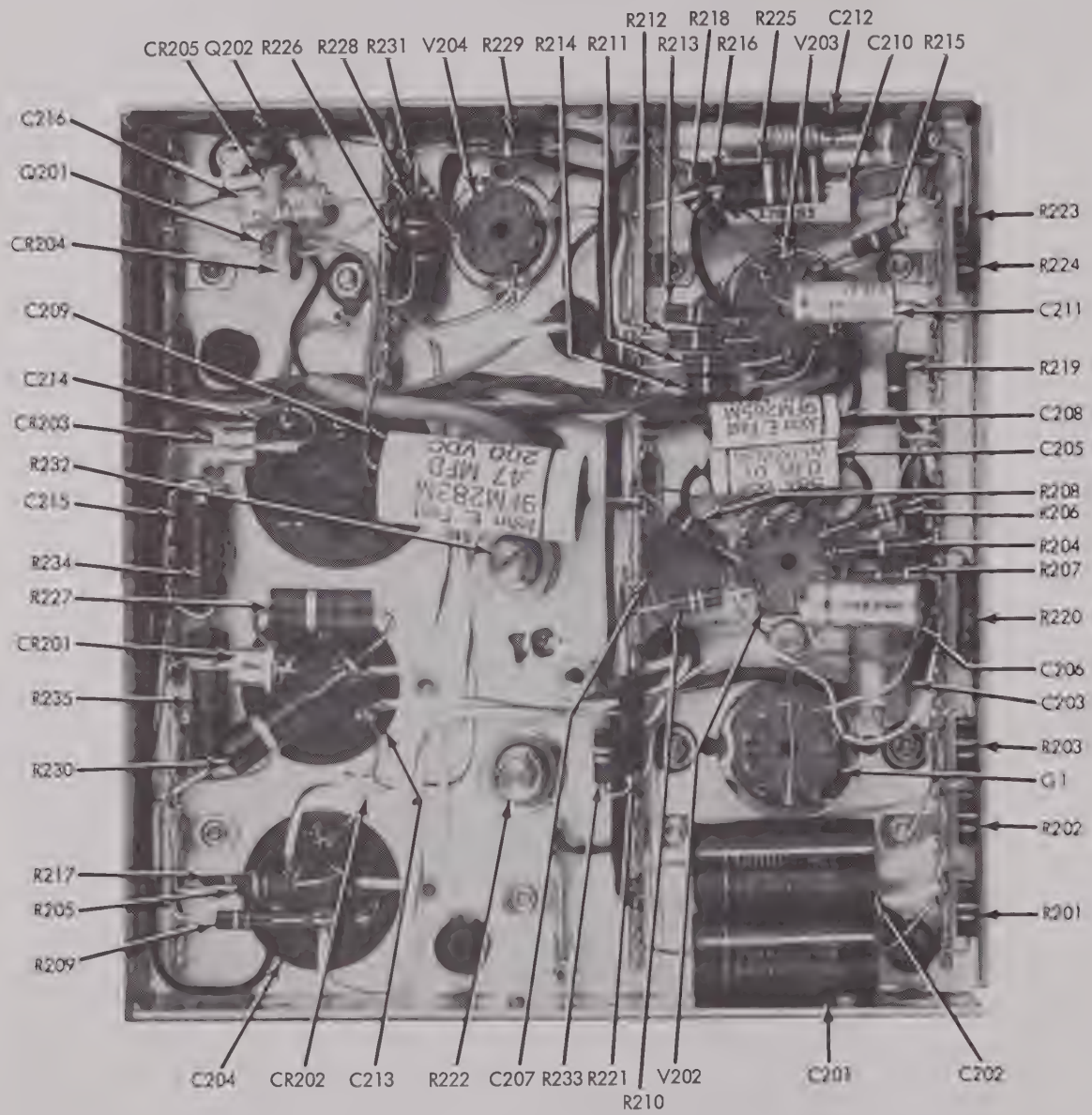


Figure 5-4. NULL DETECTOR ASSEMBLY (Sheet 1 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to 825A & 825A/AG serial numbers 1706 and on and 825AR & 825AR/AG serial numbers 629 and on.		
	Null Detector Board Assembly	168807	
	Chopper Drive Assembly	168815	
C212	Capacitor, plastic, 0.047 uf ±20%, 100V	106096	
DS202, DS203	Lamp, neon glow, type NE2U	162602	
R226	Resistor, variable composition, 100K ±30%, 3/10W	163402	
R227, R228	Resistor, composition, 390K ±10%, 1/2W	108993	
C201, C202	Capacitor, electrolytic, 0.22 uf ±20%, 100V coated with epoxy resin	*167734	
C203	Capacitor, plastic, 0.047 uf ±20%, 100V	106096	
C204	Capacitor, ceramic, 180 pf ±10%, 500V	105890	
C205	Capacitor, electrolytic, 1250 uf -10/+50%, 4V	166330	
C206	Capacitor, electrolytic, 400 uf -10/+50%, 25V	168153	
C207	Capacitor, plastic, 0.1 uf ±10%, 200V	106013	
C208	Capacitor, plastic, 0.0047 uf ±20%, 200V	106054	
C209	Capacitor, electrolytic, 5 uf -10/+75%, 25V	152009	
C210	Capacitor, electrolytic, 1250 uf -10/+50%, 4V	166330	
C211	Capacitor, electrolytic, 10 uf -10/+50%, 25V	170266	
C213, C214	Capacitor, electrolytic, 400 uf -10/+50%, 25V	168153	
CR201 thru CR203	Diode, silicon, 1 Amp, 100 PIV	116111	
DS201	Lamp, neon glow, type NE2U coated with epoxy resin	*162776	
Q201	Transistor, silicon, NPN, Type S7563	168716	
Q202 to Q206	Transistor, silicon, NPN, Type 2N3391	168708	
Q207	Transistor, silicon, PNP, Type 2N3638	169375	
R201	Resistor, composition, 270K ±10%, 1W	109512	
R202	Resistor, composition, 470K ±10%, 1/2W	108290	
R203	Resistor, metal film, 10.7Ω ±1%, 1/2W	168740	
R204	Resistor, composition, 68Ω ±10%, 1/2W	108464	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R205	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	112433	
R206	Resistor, composition, 10K ±10%, 1/2W	108118	
R207	Resistor, composition, 1M ±10%, 1/2W	108134	
R208	Resistor, composition, 10M ±10%, 1/2W	108142	
R209	Resistor, composition, 100K ±10%, 1/2W	108126	
R210	Resistor, composition, 2.2M ±10%, 1/2W	108225	
R211	Resistor, composition, 270K ±10%, 1/2W	108258	
R212	Resistor, variable composition, 100K ±20%, 1/4W	163873	
R213	Resistor, composition, 10Ω ±10%, 1/2W	108092	
R214	Resistor, composition, 180K ±10%, 1/2W	108431	
R215	Resistor, composition, 10K ±10%, 1/2W	108118	
R216	Resistor, composition, 180K ±10%, 1/2W	108431	
R217	Resistor, composition, 100K ±10%, 1/2W	108126	
R218	Resistor, composition, 27K ±10%, 1/2W	108878	
R219	Resistor, composition, 47K ±10%, 1/2W	108480	
R220	Resistor, composition, 100Ω ±10%, 1/2W	108100	
R221	Resistor, composition, 270K ±10%, 1/2W	108258	
R222	Resistor, composition, 18K ±10%, 1/2W	108183	
R223	Resistor, composition, 2.2K ±10%, 1/2W	108605	
R224, R225	Resistor, composition, 47K ±10%, 1/2W	108480	
R229	Resistor, composition, 100Ω ±10%, 1/2W	108100	
R230	Resistor, composition, 47K ±10%, 1/2W	108480	
V201 thru V203	Photoelectric cell, 5K light, 50M dark	167940	

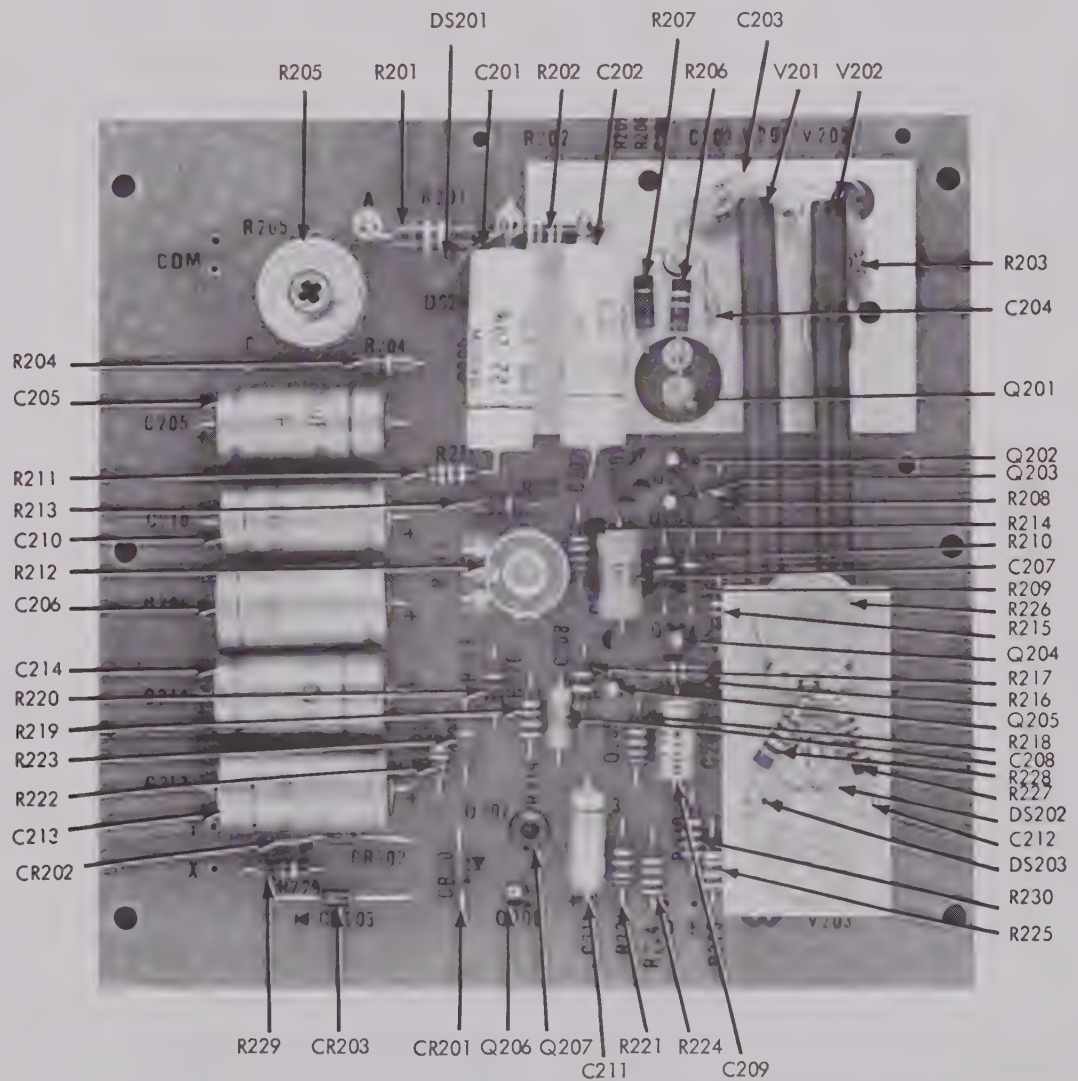


Figure 5-4. NULL DETECTOR ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Range Resistor Printed Circuit Board Assembly		
	Model 825A	*121145	M
		*152876	N
	Model 825AR	*121202	M
		*147074	N
	Model 825A/AG	*121152	M
		*153494	N
	Model 825AR/AG	*121228	M
		*153502	N
C301	Capacitor, plastic, 1 uf ±20%, 600V	105924	
C302	Capacitor, plastic, 2 uf ±20%, 200V	106443	
CR301	Zener diode (825A/AG and 825AR/AG. If replacement is required, CR301, R3, and R319 must be replaced with one of the Zener-resistor sets listed below. An adhesive label included must be attached to Range Resistor Board to give future ordering data for R3 and R319.)		
	Zener-resistor set 825A/G-426 (Replace with 158824)		O
	Zener-resistor set 825A/G-404 or 825A/G-408 (These two sets are completely interchangeable.)	158824	P
R301 thru R304	Resistor, carbon film, 10 Meg ±1%, 1W	107748	
R305	Resistor, carbon film, 9 Meg ±1%, 1W	107557	
R306	Resistor, carbon film, 900 K ±1%, 1/2W	107391	
R307	Resistor, carbon film, 90 K ±1%, 1/2W	107292	
R308	Resistor, carbon film, 9 K ±1%, 1/2W	107250	
R309	Resistor, deposited carbon, 900Ω ±1%, 1/2W	107771	
R310	Resistor, deposited carbon, 100Ω ±1%, 1/2W	107730	
R311 thru R315	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R316, R317	Resistor, wirewound, 125K ±0.1%, 1W	112102	O
	Resistor, wirewound, 112.375 K ±0.05%, 1W	112110	P
R318	Resistor, variable wirewound, 1 K ±20%, 1-1/4W	111575	Q
	Resistor, variable wirewound, 3 K ±20%, 1-1/4W	112458	R
	Resistor, variable wirewound, 1 K ±20%, 1-1/4W	113266	N
R319	Resistor, wirewound, 511.7Ω ±0.1%, 1/2W	112706	S
	Resistor, wirewound, 459.8Ω ±0.025%, 1/8W (825A and 825AR)	*132001	T
	Resistor, wirewound (825A/AG and 825AR/AG. Optimum value is selected at factory to match Zener diode. When ordering, include information listed on Range Resistor Board decal.)		
R320, R321	Resistor, wirewound, 112.375 K ±0.05%, 1W	112110	
R322	Resistor, composition, 27 K ±10%, 1W	109504	
R323	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	112433	M
	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	113258	N
R324	Resistor, wirewound, 28.571 K ±0.05%, 1/2W	112060	
R325	Resistor, wirewound, 22,5 K ±0.1%, 1/2W	112045	
R326	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	112433	M
	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	113258	N
R327	Resistor, wirewound, 2531.7Ω ±0.05%, 1/2W	111906	
R328	Resistor, wirewound, 24.75 K ±0.1%, 1/2W	112052	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R329	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	112433 113258	M N
R330	Resistor, wirewound, 250.31Ω ±0.05%, 1/2W	112011	
R331	Resistor, composition, 270Ω ±10%, 1/2W	108241	
R332	Resistor, composition, 100K ±10%, 1/2W Resistor, composition, 4.7K ±10%, 1/2W located on OPERATE-CALIBRATE switch (825A/AG and 825AR/AG).	108126 108381	W X
R333	Resistor, composition, 820K ±10%, 1/2W Resistor, composition (Optimum value selected at factory to match Zener diode. If replacement is required, replace with a resistor of same value as determined by color code. If color code is unreadable, include information listed on Range Resistor Board decal when ordering.) Located on OPERATE-CALIBRATE switch (825A/AG and 825AR/AG).	108357	W X

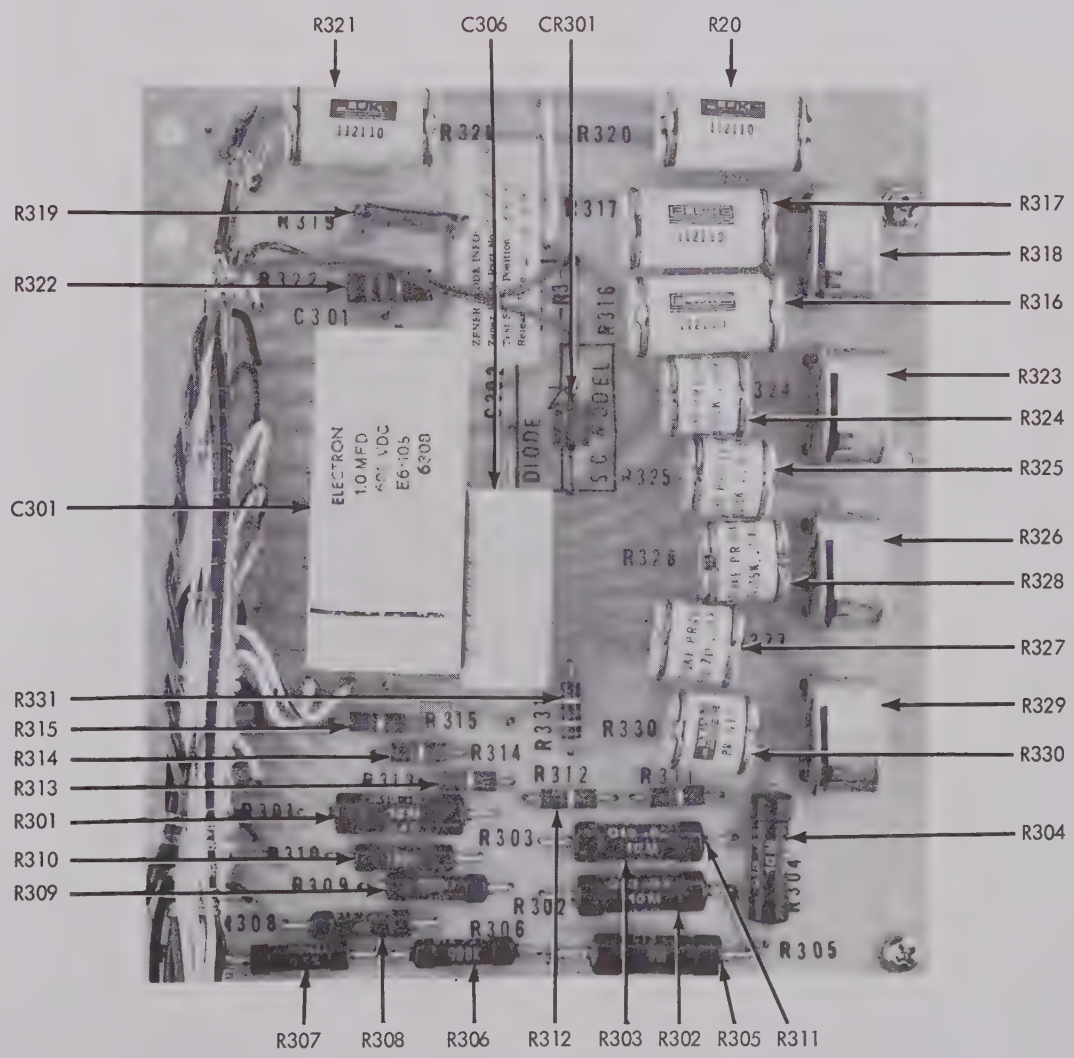


Figure 5-5. RANGE RESISTOR BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Kelvin-Varley Resistor Board Assembly	*134775	
R401 thru R406**	Resistor, wirewound, 40K ±0.02%, 1/2W	*146530	
R407 thru R417**	Resistor, wirewound, 8K ±0.005%, 1/2W	*131946	
R418 thru R428**	Resistor, wirewound, 1.6K ±0.01%, 1/8W	*131953	
R429 thru R439	Resistor, wirewound, 320Ω ±0.02%, 1/8W	*146159	
R440 thru R449	Resistor, wirewound, 64Ω ±0.1%, 1/8W	*146167	

**These resistors are factory matched for each instrument. When ordering, specify instrument model and serial number and all information stamped on resistor.

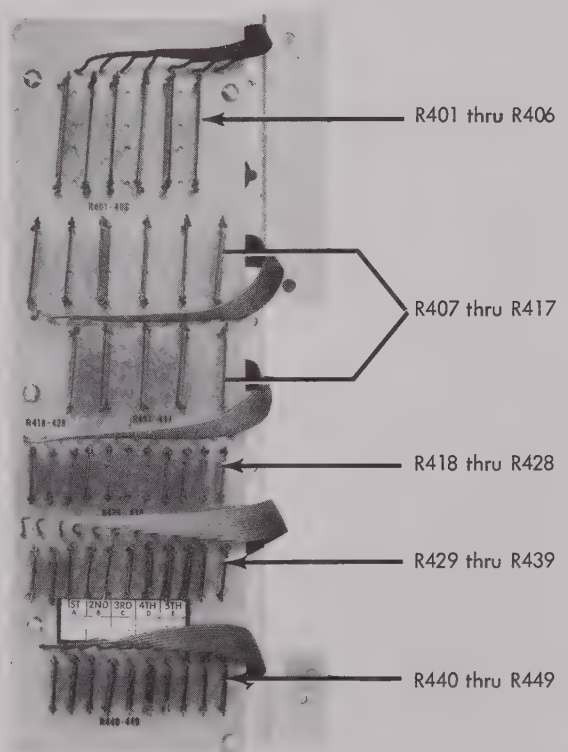


Figure 5-6. KELVIN-VARLEY RESISTOR BOARD ASSEMBLY

USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model 825A serial number 123 and on Model 825AR serial number 123 and on Model 825A/AG serial number 123 and on Model 825AR/AG serial number 123 and on
A	Model 825A serial number 123 thru 309 Model 825AR serial number 123 thru 213 Model 825A/AG serial number 123 thru 309 Model 825AR/AG serial number 123 thru 213
B	Model 825A serial number 310 and on Model 825AR serial number 214 and on Model 825A/AG serial number 310 and on Model 825AR/AG serial number 214 and on
C	Model 825A serial number 123 thru 379 Model 825AR serial number 123 thru 233 Model 825A/AG serial number 123 thru 379 Model 825AR/AG serial number 134 thru 233
D	Model 825A serial number 123 and on Model 825AR serial number 123 and on Model 825A/AG serial number 123 and on Model 825AR/AG serial number 123 and on
E	Model 825A serial number 123 thru 352 Model 825AR serial number 123 thru 223 Model 825A/AG serial number 123 thru 352 Model 825AR/AG serial number 123 thru 223
F	Model 825A serial number 353 and on Model 825AR serial number 224 and on Model 825A/AG serial number 353 and on Model 825AR/AG serial number 224 and on
G	Model 825A serial number 123 thru 669 Model 825AR serial number 123 thru 308 Model 825A/AG serial number 123 thru 669 Model 825AR/AG serial number 123 thru 308
H	Model 825A serial number 670 and on Model 825AR serial number 309 and on Model 825A/AG serial number 670 and on Model 825AR/AG serial number 309 and on
I	Model 825A serial number 123 thru 909 Model 825AR serial number 123 thru 373 Model 825A/AG serial number 123 thru 909 Model 825AR/AG serial number 123 thru 373
J	Model 825A serial number 910 and on Model 825AR serial number 374 and on Model 825A/AG serial number 910 and on Model 825AR/AG serial number 374 and on
K	Model 825A serial number 123 thru 1129 Model 825AR serial number 123 thru 463 Model 825A/AG serial number 123 thru 1129 Model 825AR/AG serial number 123 thru 463
L	Model 825A serial number 1130 and on Model 825AR serial number 464 and on Model 825A/AG serial number 1130 and on Model 825AR/AG serial number 464 and on
M	Model 825A serial number 123 thru 1220 Model 825AR serial number 123 thru 477 Model 825A/AG serial number 123 thru 1220 Model 825AR/AG serial number 123 thru 477
N	Model 825A serial number 1221 and on Model 825AR serial number 478 and on Model 825A/AG serial number 1221 and on Model 825AR/AG serial number 478 and on
O	Model 825A serial number 123 thru 1220 Model 825AR serial number 123 thru 492 Model 825A/AG serial number 123 thru 1220 Model 825AR/AG serial number 123 thru 492
P	Model 825A serial number 1221 and on Model 825AR serial number 493 and on Model 825A/AG serial number 1221 and on Model 825AR/AG serial number 493 and on
Q	Model 825A serial number 123 thru 1220 Model 825AR serial number 123 thru 477
R	Model 825A/AG serial number 123 thru 1220 Model 825AR/AG serial number 123 thru 477
S	Model 825A serial number 123 thru 1220 Model 825AR serial number 123 thru 492
T	Model 825A serial number 1221 and on Model 825AR serial number 493 and on
U	Model 825A serial number 123 thru 1239 Model 825AR serial number 123 thru 513 Model 825A/AG serial number 123 thru 1239 Model 825AR/AG serial number 123 thru 513
V	Model 825A serial number 1240 and on Model 825AR serial number 514 and on Model 825A/AG serial number 1240 and on Model 825AR/AG serial number 514 and on
W	Model 825A/AG serial number 123 thru 1364 Model 825AR/AG serial number 123 thru 573
X	Model 825A/AG serial number 1365 and on Model 825AR/AG serial number 574 and on
Y	Model 825A serial number 380 thru 1239 Model 825AR serial number 234 thru 513 Model 825A/AG serial number 380 thru 1239 Model 825AR/AG serial number 123 thru 513

USE CODE

Z — Model 825A serial number 123 thru 1694
Model 825AR serial number 123 thru 622
Model 825AR/AG serial number 123 thru 1694
Model 825A/AG serial number 123 thru 622

AA — Model 825A serial number 1695 and on
Model 825AR serial number 623 and on
Model 825A/AG serial number 1695 and on
Model 825AR/AG serial number 623 and on

AB — Model 825A serial number 123 thru 1705
Model 825AR serial number 123 thru 628
Model 825A/AG serial number 123 thru 1705
Model 825AR/AG serial number 123 thru 628

AC — Model 825A serial number 1706 and on
Model 825AR serial number 629 and on
Model 825A/AG serial number 1706 and on
Model 825AR/AG serial number 629 and on

AD — Model 825A serial number 380 thru 1705
Model 825AR serial number 234 thru 628
Model 825A/AG serial number 380 thru 1705
Model 825AR/AG serial number 234 thru 628

AE — Model 825A serial number 123 thru 1705
Model 825AR serial number 123 thru 629
Model 825A/AG serial number 123 thru 1705
Model 825AR/AG serial number 123 thru 629

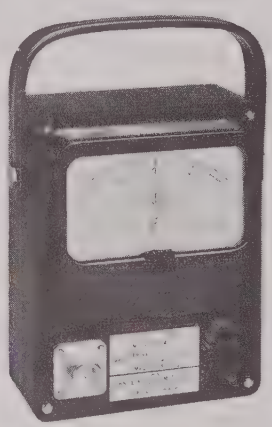
AF — Model 825A serial number 1706 and on
Model 825AR serial number 630 and on
Model 825A/AG serial number 1706 and on
Model 825AR/AG serial number 630 and on

SECTION VI

ACCESSORIES

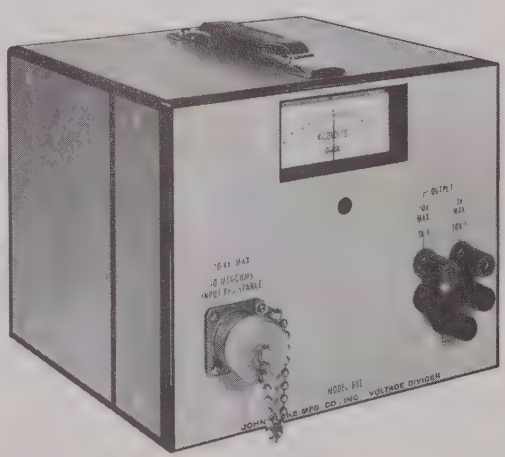
6-1. PRECISION VOLTAGE DIVIDERS

6-2. The FLUKE 80A, 80D, and 80E Voltage Dividers provide the FLUKE 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80D dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80D and 80E models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A

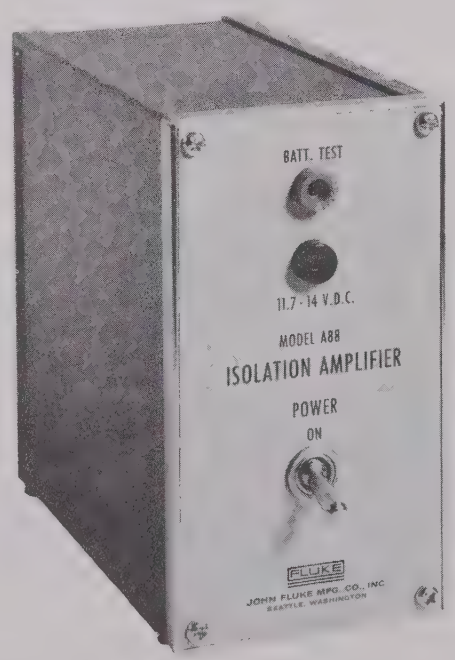
MODEL 80D



MODEL 80E

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio			Division Ratio Accuracy	Stability of Division Accuracy Per Year
				500V Out	10V Out	1V Out		
80A-1	1 KV	1 M	1 ma	2:1	——	——	±0.015%	——
80A-2	2 KV	2 M	1 ma	4:1	——	——	±0.015%	——
80E-5	5 KV	5 M	1 ma	—	500:1	5,000:1	±0.01%	±0.01%
80E-10	10 KV	10 M	1 ma	—	1000:1	10,000:1	±0.01%	±0.01%
80D-30	30 KV	30 M	1 ma	60:1	3000:1	30,000:1	±0.01%	±0.01%

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80E	7" high 8-1/2" wide 8" deep	MS3102A-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80D	13" high 9-3/4" wide 16" deep	Special 5" ceramic standoff with mating 6" guard supplied	Insulated binding post on 3/4" centers for both outputs



MODEL A88 ISOLATION AMPLIFIER

6-3. ISOLATION AMPLIFIER

6-4. The FLUKE Model A88 all solid-state isolation amplifier is designed to provide isolation between the output of a differential voltmeter and the input of a recorder. Thus, the A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder. The A88 is also excellent for making accurate dc microvolt and nanoampere measurements in the presents of common mode voltages up to 1100 vdc and 3 vac, 50 to 500 cycles.

GAIN: 1 volt output per microampere input.

GAIN ACCURACY: ±2%.

INPUT CURRENT RANGE: 0 to 2 microamperes.

INPUT VOLTAGE RANGE: 0 to 2 millivolts nominal.

INPUT RESISTANCE: 950 ohms (±5%).

OUTPUT VOLTAGE RANGE: 0 to 2 volts open circuit.

OUTPUT RESISTANCE: 1000 ohms (±5%).

INPUT ISOLATION FROM CHASSES: Greater than 5×10^{11} ohms at 25°C (77°F), 60% RH and 1×10^{10} ohms at 50°C (122°F), 80% RH.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

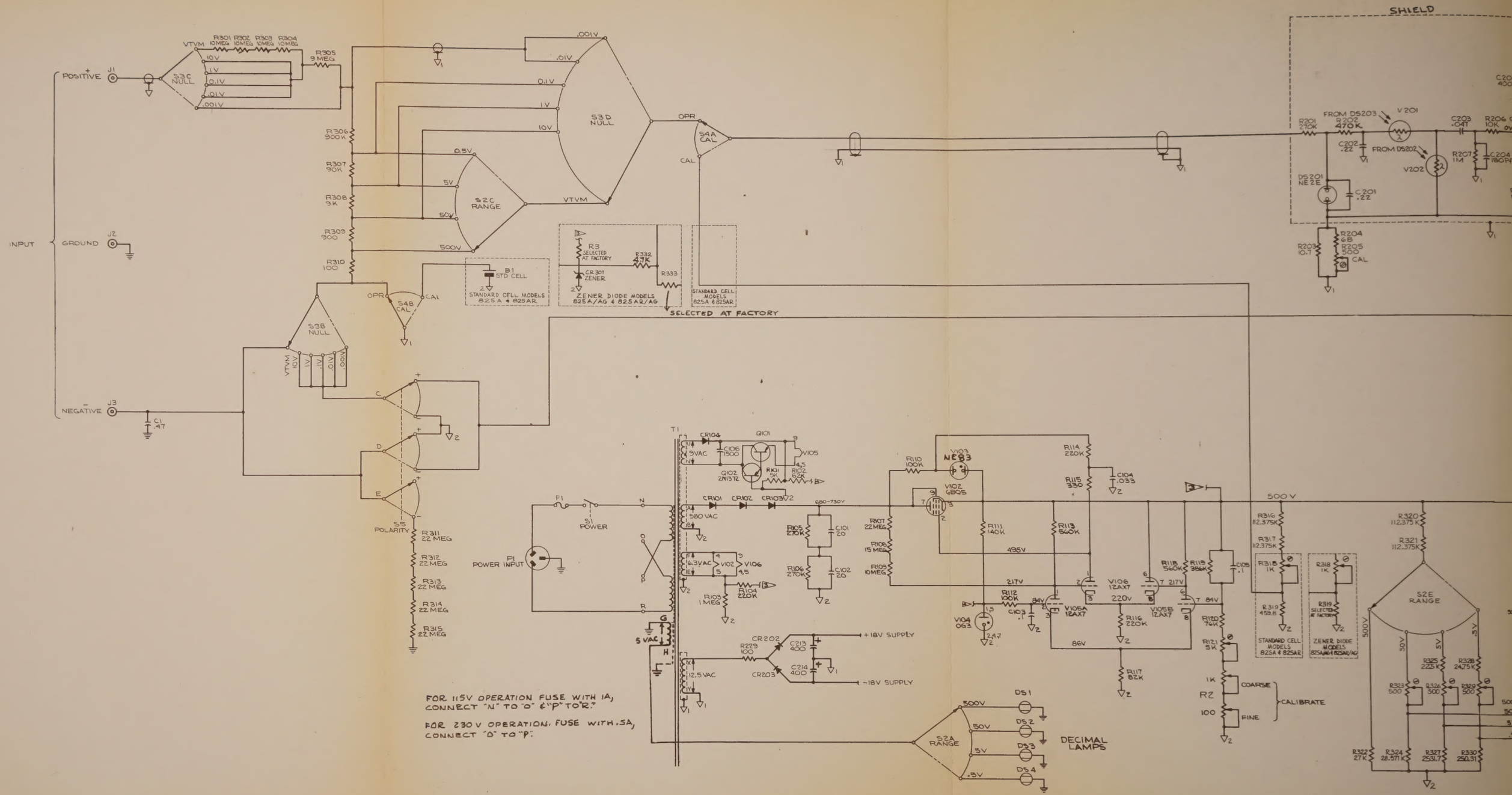
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

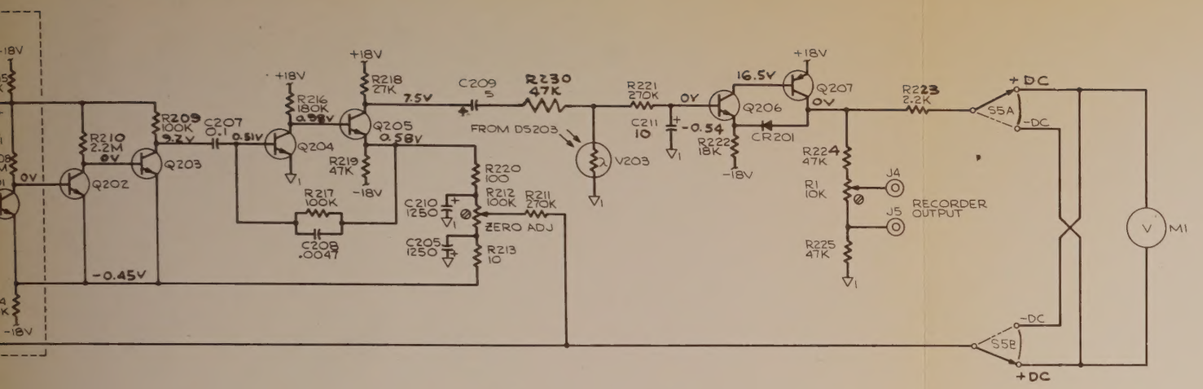
CLAIM FOR DAMAGE IN SHIPMENT

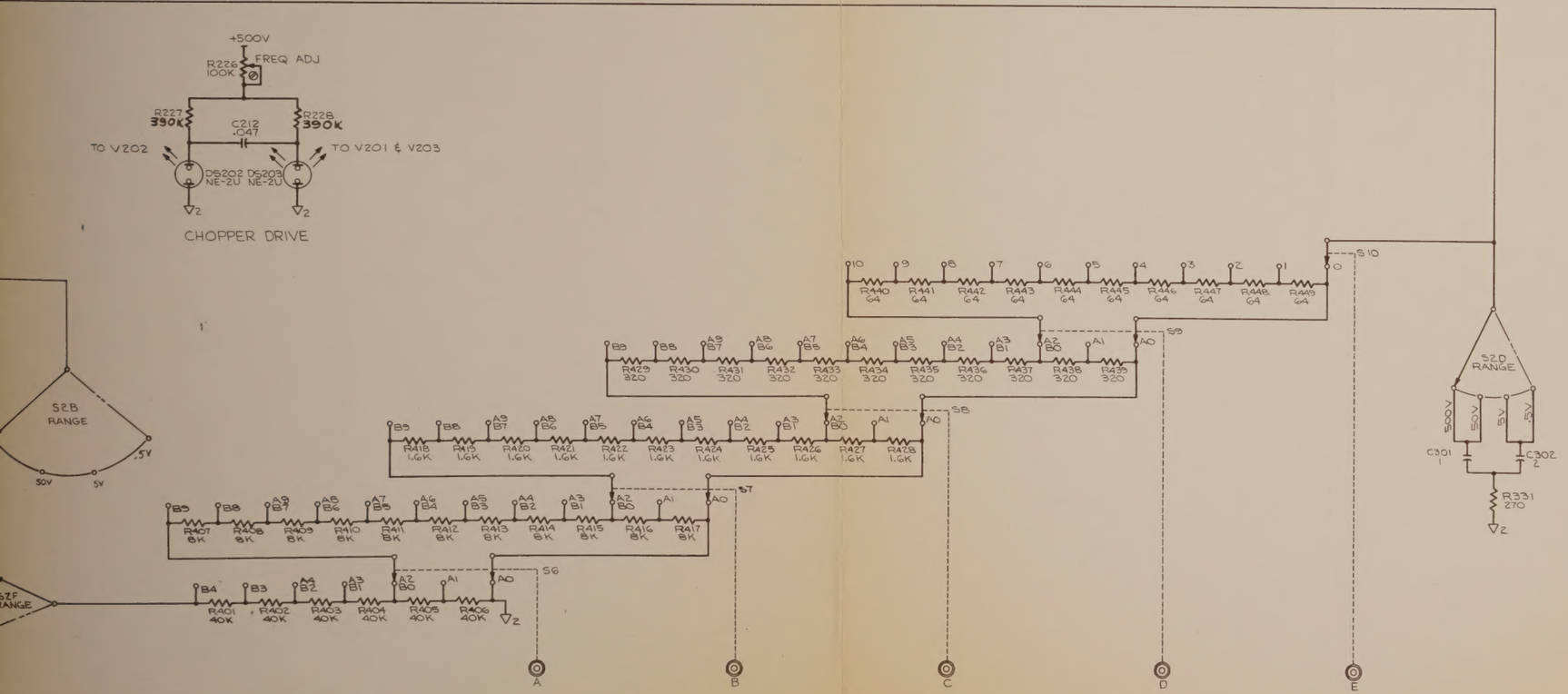
The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON


SHIELD
INPUT
POSITIVE J1
GROUND J2
NEGATIVE J3
C1 .47
VTVM
R301 10MEG
R302 10MEG
R303 10MEG
R304 10MEG
R305 9 MEG
S3C NULL
10V
1V
.1V
.01V
.001V
R306 900K
R307 90K
R308 9K
R309 900
R310 100
S3D NULL
S2C RANGE
.5V
5V
50V
500V
VTVM
OPR
CAL
S4A CAL
S4B CAL
S3B NULL
B1 STD CELL
STANDARD CELL MODELS 825A & 825AR
R3 SELECTED AT FACTORY
CR301 ZENER
R332 4.7K
R333
ZENER DIODE MODELS 825A/AG & 825AR/AG
STANDARD CELL MODELS 825A & 825AR
SELECTED AT FACTORY
S5 POLARITY
R311 22 MEG
R312 22 MEG
R313 22 MEG
R314 22 MEG
R315 22 MEG
C
D
E
F1
P1 POWER INPUT
S1 POWER
T1
CR104
Q101
C106 1500
Q102 2N1372
R101 15K
R102 50K
V105
4.5
9VAC
580 VAC
6.3VAC
5 VAC
12.5 VAC
CR101
CR102
CR103
680-730V
R105 270K
R106 270K
C101 20
C102 20
V102 6BQ5
V106 12AX7
R103 1 MEG
R104 220K
CR202
CR203
R229 100
C213 400
C214 400
+18V SUPPLY
-18V SUPPLY
FOR 115V OPERATION FUSE WITH 1A, CONNECT "N" TO "O" & "P" TO "R."
FOR 230 V OPERATION, FUSE WITH .5A, CONNECT "O" TO "P".
V103 NE83
R110 100K
R107 22 MEG
R108 15 MEG
R109 10 MEG
R111 140K
R114 220K
R115 330
C104 .033
R113 540K
495V
217V
84V
220V
86V
V105A 12AX7
V105B 12AX7
R116 220K
R117 82K
R118 560K
R119 360K
C105 .1
R120 74K
R121 5K
1K
R2
100
COARSE
FINE
CALIBRATE
500V
R316 112.375K
R317 112.375K
R318 1K
R319 459.8
R319 SELECTED AT FACTORY
STANDARD CELL MODELS 825A & 825AR
ZENER DIODE MODELS 825AR/AG
R320 112.375K
R321 112.375K
S2E RANGE
50V
5V
.5V
R325 225K
R328 24.75K
R322 27K
R324 28.571K
R327 253.7
R330 250.31
V104 OG3
V101 NE2E
DS201 NE2E
V201
V202
FROM DS203
FROM DS202
R201 270K
R202 470K
C202 .22
C203 .041
R206 10K
R207 1M
C204 180PF
C201 .22
R203 10.7
R204 68
R205 500 CAL
S2A RANGE
DS1
DS2
DS3
DS4
DECIMAL LAMPS





NOTES

1. All voltage measurements shown are taken under the following conditions:
   (a) RANGE switch set to 500.
   (b) NULL switch set to VTVM.
   (c) All voltage readout dials set to zero.
   (d) Polarity switch set to +.
   (e) Line voltage at 115/230 volts, 50-400 cycles.
   (f) All measurements made with a VTVM (10 megohms input resistance) to the negative binding post.
2. All voltages are DC unless otherwise indicated.
3. $\overset{\nabla_1}{\perp}$ Indicates null detector common.
4. $\overset{\nabla_2}{\perp}$ Indicates reference supply common.
5. $\overset{\nabla_1}{\perp}$ and $\overset{\nabla_2}{\perp}$ may differ in voltage by amount indicated on voltage readout dials.
6. ▷ All flagnotes with the same number are connected.
7. ⊘ Indicates internal adjustment.
8. Unless otherwise indicated, resistances are in ohms and capacitances are in microfarads.
9. * INDICATES MAY BE OMITTED.

FUNCTIONAL SCHEMATIC d

DIFFERENTIAL VOLTMETER

MODEL 825A, 825AR, 825A/AG & 825AR/AG

825A, 825AR, SER. NO. 1706 & ON
825A/AG & 825AR/AG SER. NO. 629 & ON

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8/A/AR/AG, 9A, A25B

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